CONSEIL PERMANENT INTERNATIONAL POUR
L'EXPLORATION DE LA MER

RAPPORTS

ET

PROCÈS-VERBAUX DES RÉUNIONS

VOLUME LXXI

REPORT OF THE TRANSITION AREA COMMITTEE CONCERNING PLAICE-INVESTIGATIONS IN THE KATTEGAT AND SKAGERAK

EN COMMISSION CHEZ
ANDR. FRED. HØST & FILS
COPENHAGUE

Prix: Kr. 4.50.

750. II. 1931

Février 1931

COPENHAGUE — IMPRIMERIE BIANCO LUNO A/S

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PREFACE

The object of the present report is to elucidate the question whether it would be desirable to take special measures for the protection or increase of the stock of plaice in the Kattegat and the Skagerak beyond the provisions already made, partly by a convention between Denmark and Sweden, and partly by special clauses in the fishing laws of the countries interested. The stock of plaice was the object of very extensive investigations from 1903 to 1909, and again in recent years. Parallel with a presentation of the decrease in the yield of the fisheries in the period 1901—1929, and of how the fishing was carried on with increasing intensity in the course of these years, the present report throws light on the changes which the size and composition of the stock and the growth of the individual plaice have undergone.

Copenhagen, May 20th 1930.

A. C. Johansen.

Investigations on the Stock of Plaice in the Kattegat and the Belts in the Years 1927—1929.

By

Aage J. C. Jensen.

I. The Material for the Investigation. The Objects of the Investigation.

In the years 1927, 1928, and 1929 a considerable number of quantitative fishing experiments were carried out with a fine-meshed otter seine, the so-called *tog*, by the Danish Biological Station chiefly with a view to procuring material for the investigation of the plaice stock in the different parts of the Kattegat, together with the Sound and the Belts.

In the Table below are given the numbers of the quantitative fishing experiments and the total numbers of plaice caught with the fine-meshed otter seine and examined for sex, length and age.

	Kattegat including the Sound		The Belts	
Year	No. of stations	No. of plaice invest.	No. of stations	No. of plaice invest.
1927	75	1798	40	329
1928	45	1952	56	579
1929	91	966	32	44

In the figure for the Belts in 1928 are included 480 plaice which were caught in Kerteminde Bay at non-quantitative fishing experiments.

In the present investigation various analyses of plaice caught in commercial fishing operations (with plaice nets, otter seine and Danish seine) are also utilised.

The fishing experiments afford important data for estimating the capacity of the areas to supply the fishery. They give us information as to which areas within the Kattegat and the Belts are nursery grounds for the young plaice, they enable us to determine the average lengths of the different age-groups in the various areas and at various times of the year, and finally they enable us to investigate what fluctuations take place in the frequencies of the different year-classes within a series of years.

It is of particularly great importance that the investigations of recent years can be compared with those of former periods and that the conditions in the Kattegat can be compared with those in the Belts, where the intensive fishery in the last twenty years has brought about very nearly catastrophic conditions for the plaice fishery[1]).

[1]) A. C. Johansen: On a proposed close season for the plaice fishery in the Belt Sea and in the Baltic. Cons. perm. intern. Rapports et Procès-Verbaux. Vol. XLVIII. 1928.

II. The numerical Distribution of the total Stock and of the different Size and Age-Groups.

The frequencies of the plaice of the different age-groups and of the total stock during the years 1927, 1928, and 1929 are shown in the Charts, Figs. 1—5.

A. General Distribution of the total Stock.

The Charts, Fig. 1 show the total numbers of plaice caught per 30 minutes' haul. We notice here at once that the density of population is very great only in the area Aalbæk Bay—Herthas Flak, and — especially in 1927 — along the coast of Jutland southwards as far as Mariager Fjord. These areas present a great contrast with the others where the density in general is very low. Only in a few areas of small extent in the Belt Sea, such as Kerteminde Bay and Baaring Vig was the density found to be as great as the average density in the area Aalbæk Bay—Herthas Flak.

The Charts show that the age-groups I, II, and III predominate in all the areas investigated with the exception of two localities, viz. the southern part of the Kattegat at greater depths than 20 metres, and the Sound (in 1929).

Variations appear in the relative frequencies of the different age-groups from year to year; these will be discussed more closely in a later section p. 40).

It will be seen moreover from the Charts that the frequency is generally greatest near the coast and decreases out towards the deeper water whilst at the same time the average age increases.

If we investigate the distribution of the different size-groups we shall find that the average size of the plaice also increases from the coast out towards the deeper water (cp. p. 18, and 23).

B. The Plaice Stock in the separate Areas.

If we now turn to investigate the distribution more closely we shall find it most practical to divide up the area investigated. The following areas will be examined more closely below (cp. Chart, Fig. 6).

1. The northern Kattegat.
2. The middle and southern Kattegat, including the Sound and the Isefjord.
3. The Belts.

1. The northern Kattegat.

From the northern Kattegat north of Læsø, the fishing experiments were sufficiently comprehensive only in the area Aalbæk Bay—Herthas Flak. In addition to these a few fishing experiments in the area around Læsø will be discussed.

The area Aalbæk Bay—Herthas Flak is bounded naturally (cp. Chart, Fig. 6) in the south by the line from Stensnæs to the western point of Læsø, and in the

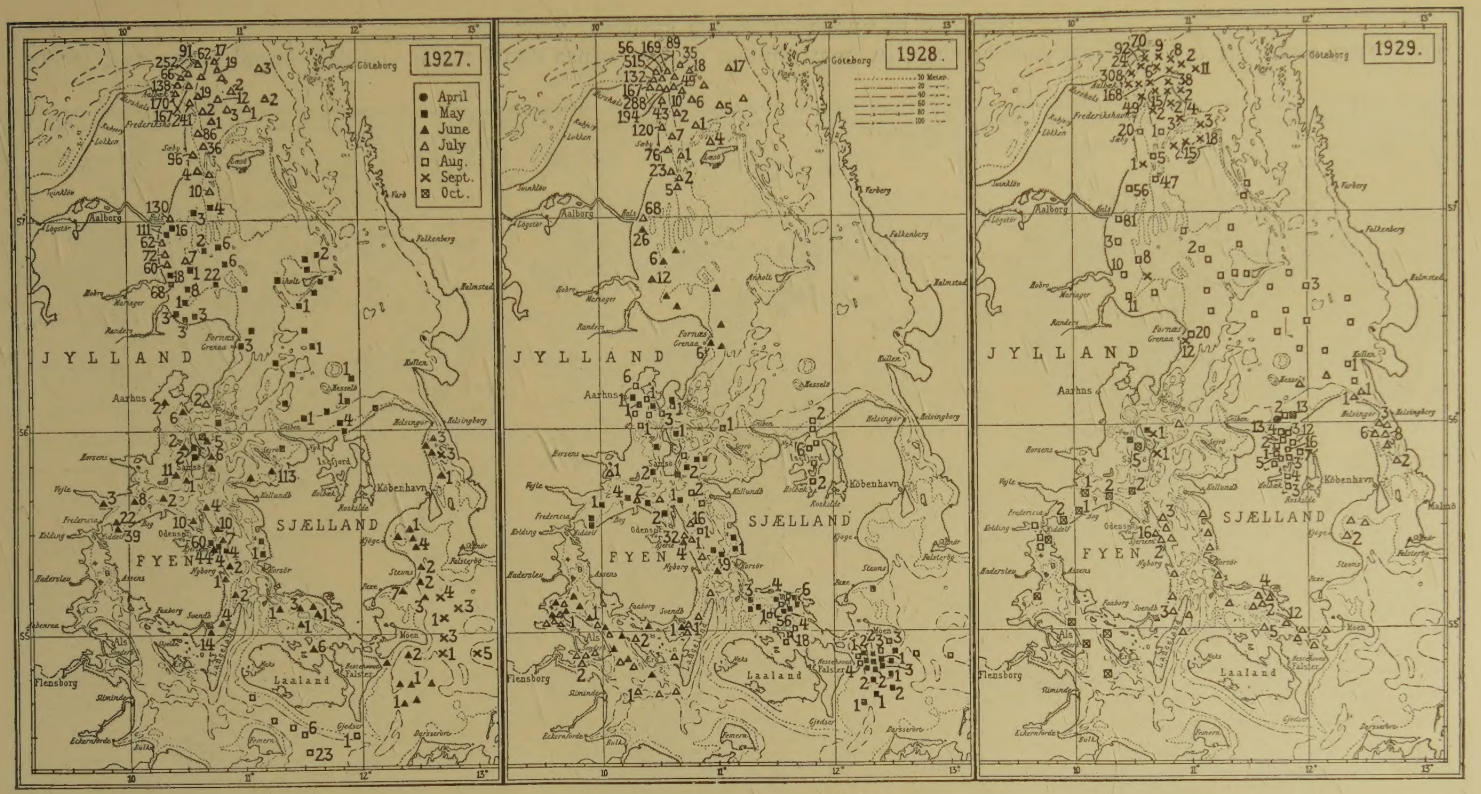

Fig. 1. Total number of plaice caught per 30 minutes haul with fine-meshed otter-seine in the years 1927, 1928, and 1929.

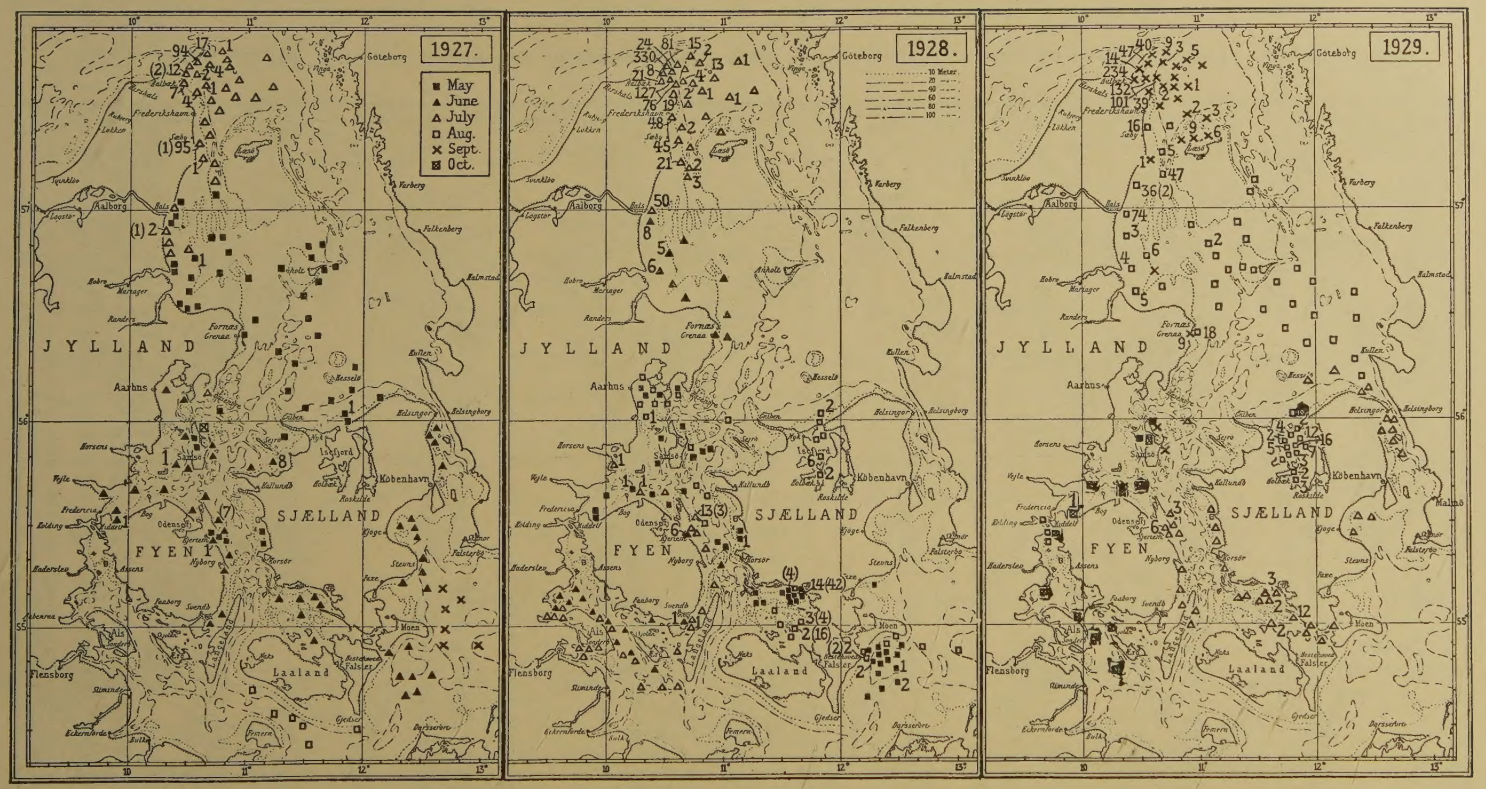

Fig. 2. Number of plaice of the 0- and I-group caught per 30 minutes haul with fine-meshed otter-seine in the years 1927, 1928, and 1929. Numbers of 0-group shown in brackets.

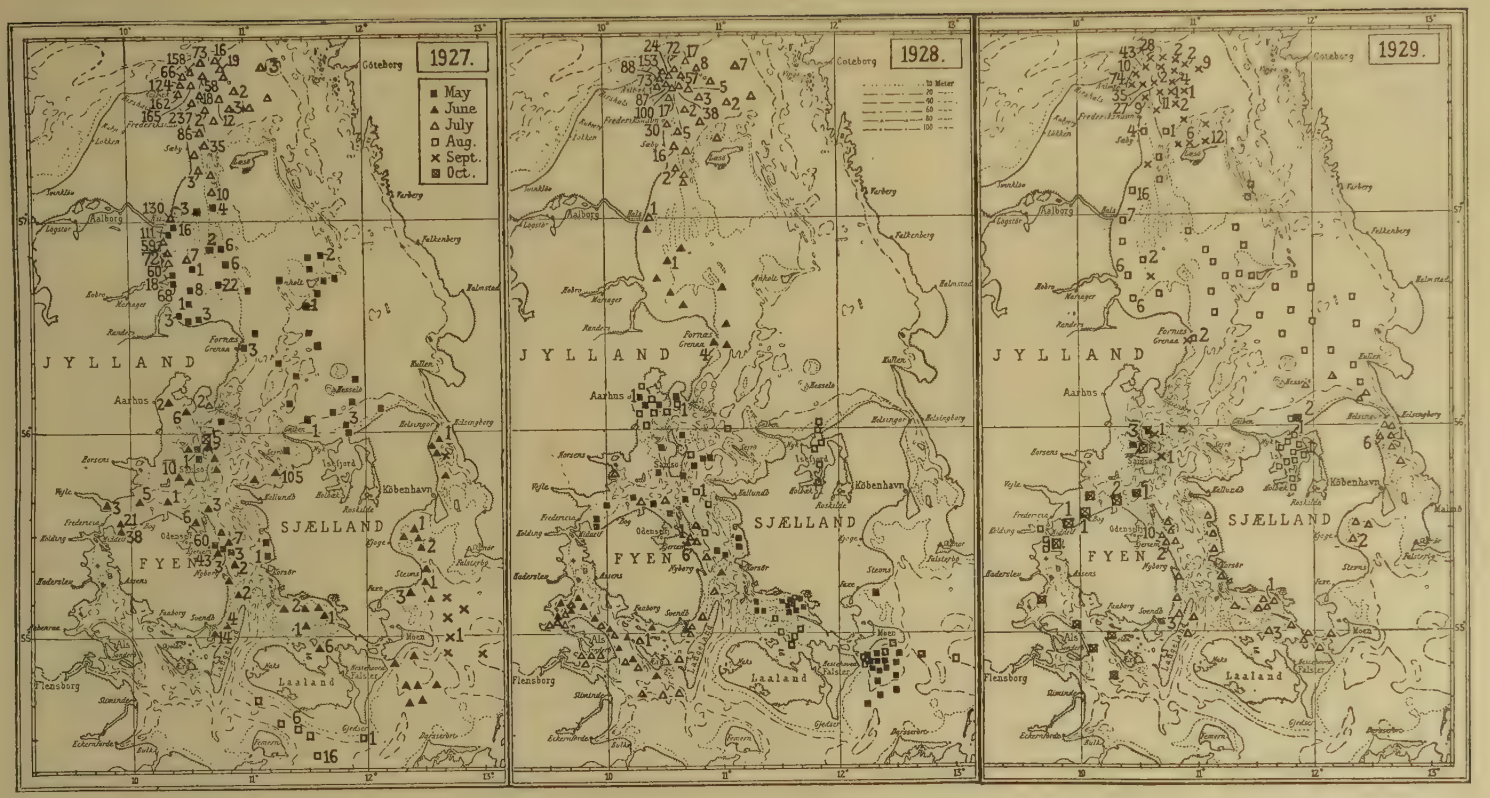

Fig. 3. Number of plaice of the II-group caught per 30 minutes haul with fine-meshed otter-seine in the years 1927, 1928, and 1929.

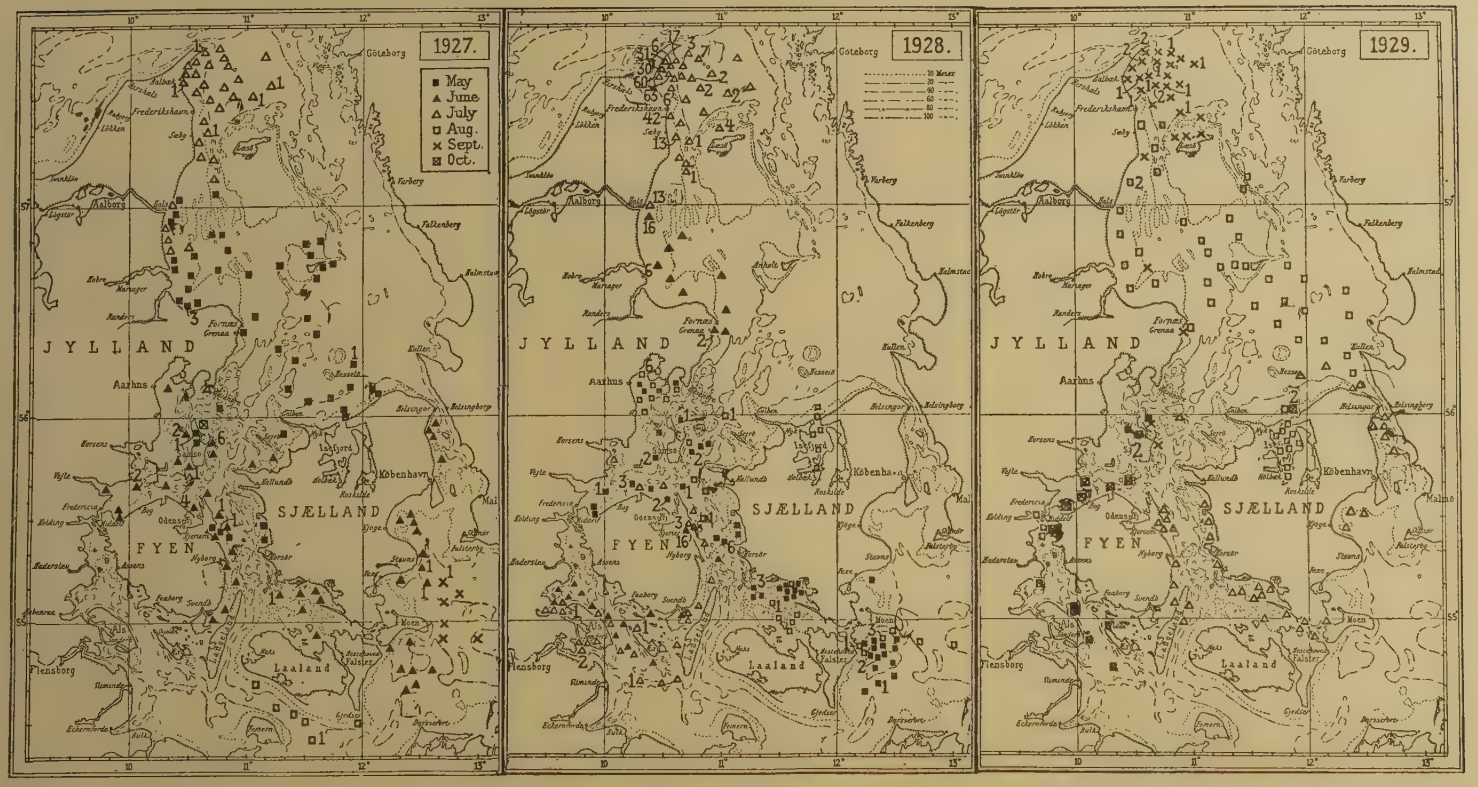

Fig. 4. Number of plaice of the III-group caught per 30 minutes haul with fine-meshed otter-seine in the years 1927, 1928, and 1929.

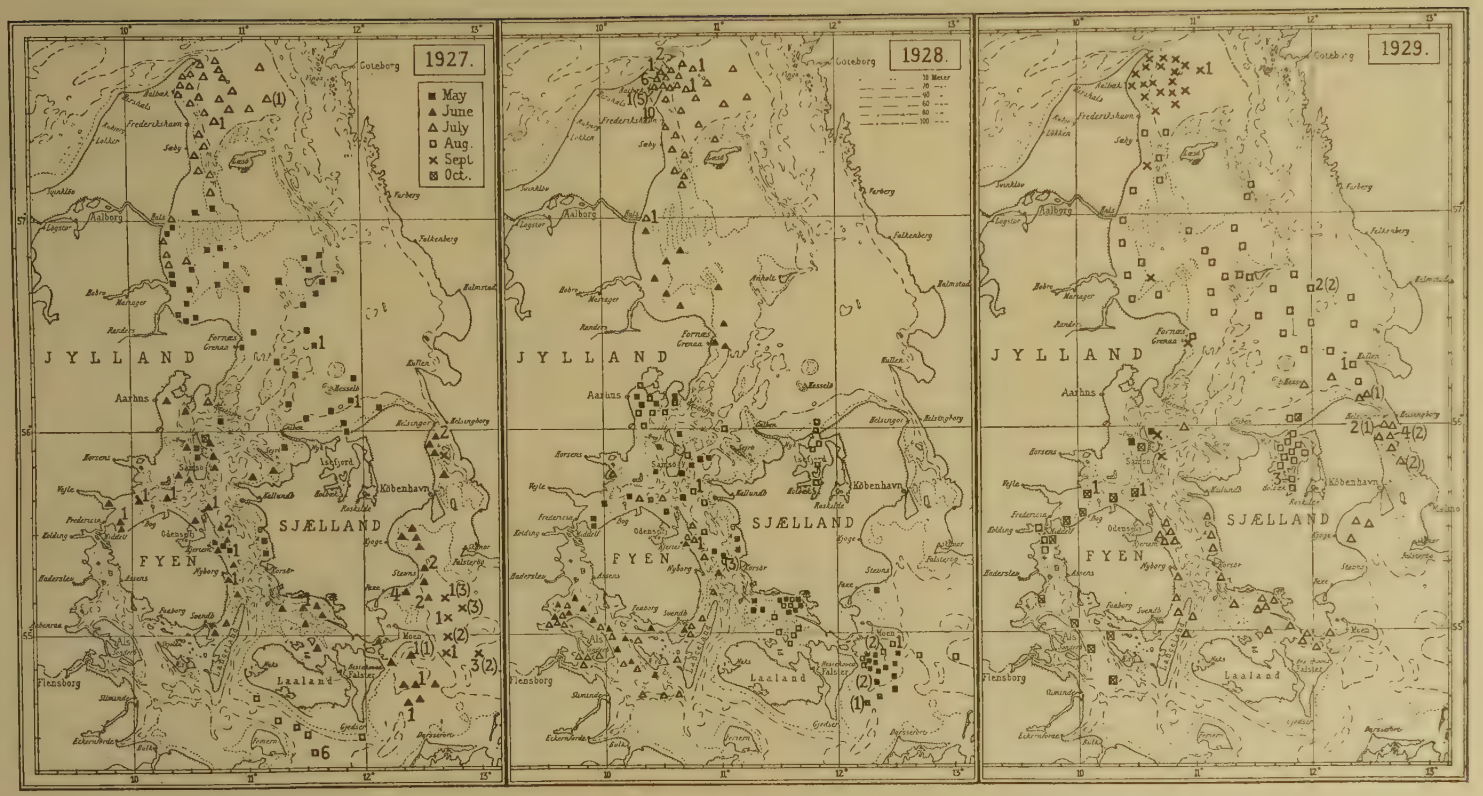

Fig. 5. Number of plaice of the IV-group and, in brackets, of the V-group and older caught per 30 minutes haul with fine-meshed otter-seine in the years 1927, 1928, and 1929.

Fig. 6. Showing the Kattegat, and the Belt Sea, with the divisions and names used.

south-west by a line through the channel which extends between Herthas Flak and Læsø Flak towards the south-west from the deeper north-easterly Kattegat.

Within this area in the three years 1927, 1928, and 1929 fishing experiments were carried out with the tog at 68 stations distributed over the whole area. In all 3872 plaice were caught in that area and examined. The total number of plaice and their distribution among the different size and age-groups are shown in Tables 1, 2, and 3 for the years 1927, 1928, and 1929 respectively.

Table 1. Number of plaice of the different age- and size-groups caught per 30 min. haul with fine-meshed otter seine in the Aalbæk Bay—Herthas Flak Area, July 1927.

Depth ms.	Stat. No.	Date July	Age-Groups					Size-Groups, cms.							Total
			I	II	III	IV	V	5-9	10-14	15-19	20-24	25-29	30-34	35-39	
6	246	7	1	95	..	..	..	..	2	44	48	2	..	..	96
6.5	259	10	7	162	1	..	..	1	12	130	36	1	..	..	170
6.5	422	26	..	66	..	..	..	..	..	12	44	10	..	..	66
7	421[1]	26	12	124	..	..	..	2	12	66	50	8	..	..	138
11	258	10	2	165	..	..	..	..	4	69	92	2	..	..	167
13	260	10	4	237	..	..	..	..	11	160	68	2	..	..	241
13.5	423	26	94	158	..	..	..	..	92	114	45	1	..	..	252
15	248	7	..	86	..	..	..	..	..	11	68	7	..	..	86
15	256	10	17	73	1	..	..	2	26	53	9	1	..	..	91
17.5	247	7	..	35	1	..	..	..	..	6	29	..	1	..	36
20	257	10	4	58	..	..	..	2	11	36	12	1	..	..	62
22	255	26	1	16	..	..	..	..	1	12	4	..	..	..	17
23.5	420	9	1	18	..	..	..	..	..	4	15	..	..	..	19
25	254	9	..	19	..	..	..	..	..	8	11	..	..	..	19
28	251	9	..	12	..	..	..	..	..	1	9	1	1	..	12
30	250	9	..	2	..	..	..	..	..	1	1	..	..	..	2
30	252	9	..	2	..	..	..	..	..	..	2	..	..	..	2
38	429	28	..	3	..	..	..	..	..	..	2	1	..	..	3
40	249	8	..	..	..	1	..	..	..	..	..	..	1	..	1
42	428	28	..	..	1	..	..	..	..	..	..	1	..	..	1
43	426	28	..	3	..	..	..	..	..	2	1	..	..	..	3
45	427	28	..	..	1	..	1	..	..	..	..	..	1	1	2

[1]) Besides the plaice shown under the age-groups at this station were caught 2 plaice of the 0-group per 30 min. haul.

It will be seen from the Tables, as from the Charts, that the greatest density of plaice was found within the 15 metre line and that it decreased out towards the deeper water, whilst their average age and average size at the same time increased.

We obtain a better and more reliable idea of the distribution by taking the fishing experiments in the three years together, as is done in Table 4, p. 18.

It will be seen that in depths of less than 25 metres about 97 % of the plaice are under 25 cm. in length, and that the plaice over 26 cm. (the Danish minimum size

Table 2. Number of plaice of the different age- and size-groups caught per 30 min. haul with fine-meshed otter seine in the Aalbæk Bay—Herthas Flak area, July 1928.

Depth ms.	Stat. No.	Date July	Age-Groups					Size-Groups, cms.							Total
			I	II	III	IV	V	?	5-9	10-14	15-19	20-24	25-29	30-34	
6	1086	9	48	30	42	..	..	..	..	18	36	60	6	..	120
6.5	1088	10	21	73	60	5	1	7	6	18	54	74	15	..	167
6.5	1096	12	8	88	30	6	..	..	..	8	48	60	16	..	132
7.5	1080	8	45	16	13	..	..	2	..	30	25	15	5	1	76
7.5	1095	12	330	153	31	1	..	..	49	292	130	42	2	..	515
10	1097	12	24	24	6	2	..	..	..	22	8	22	4	..	56
11	1089	10	127	87	63	10	..	1	15	118	64	73	18	..	288
13	1087	10	19	17	6	..	..	1	1	17	16	8	1	..	43
15	1079	8	2	5	..	..	..	..	..	..	3	4	..	..	7
16	1090	10	76	100	18	..	..	..	5	76	90	23	..	..	194
18	1103	13	81	71	17	..	..	..	1	80	68	19	1	..	169
20	1081	8	..	..	1	..	..	..	..	..	..	1	..	..	1
21	1104	13	13	57	19	..	..	..	..	13	35	37	..	..	89
21.5	1098	12	4	38	7	..	..	..	..	4	19	25	1	..	49
25.5	1101	12	2	8	7	1	..	..	..	1	8	8	1	..	18
26	1099	12	2	5	2	1	..	..	..	2	2	3	3	..	10
27	1102	12	15	17	3	..	..	..	..	12	16	7	..	..	35
28	1082	8	..	2	..	..	..	..	..	..	1	1	..	..	2
29.5	1100	12	..	..	..	..	..	..	..	..	..	..	..	..	0
30	1083	8	1	3	2	..	..	..	..	1	..	5	..	..	6
40	1084	9	..	..	1	..	..	..	..	..	..	..	1	..	1
41	1092	11	1	2	2	..	..	..	..	1	1	2	1	..	5
42	1094	11	1	7	9	..	..	..	..	1	6	5	2	3	17
50	1093	11	..	..	..	..	..	..	..	..	..	..	..	..	0

is 25.7 cm.) only constitute a very small fraction, about 1 %, of the total number of plaice in depths less than 25 metres. Between 25 and 35 metres' depth they constitute about one eighth of the stock, and at the fishing experiments above this depth up to about 45 metres approximately one third of the stock. Plaice exceeding 30 cm. in depths up to 35 metres constitute only a minute fraction of the stock, but in depths above 35 metres about one fifth of the stock.

Fig. 7 shows what percentage of the stock the plaice over 26 cm. in length in the various depth zones constitute. It will be seen that in the depths greater than 30 metres the plaice over 26 cm. in length constitute about twenty times greater a percentage of the stock than in the depths up to 25 metres.

The area Aalbæk Bay—Herthas Flak is thus up to a depth of about 35 metres a pronounced nursery ground.

This will also be noticed when we consider the age composition of the stock. Age groups younger than the III-Group consitute more than 90 % of the plaice out to a

depth of 35 metres and about 50 % beyond this depth, whilst the plaice older than the III-Group constitute less than a fifteenth part of the stock in depths up to 35 metres and a seventeenth part of the stock in depths over 35 metres. Furthermore, Tables 1—4 show that the density has been on the whole about the same in all three years, although there have been considerable differences from year to year in the relative frequencies of the different age-groups.

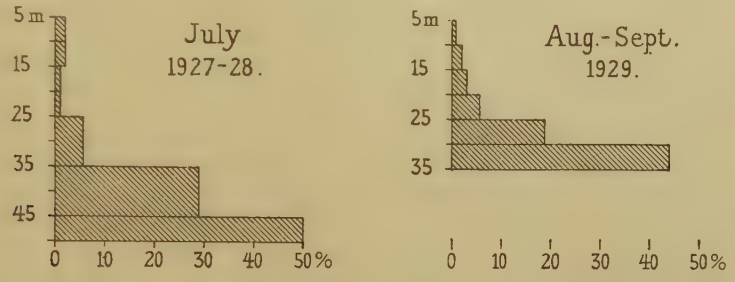

Fig. 7. Percentage of plaice above 26 cms. length in the various depth zones in the Aalbæk Bay—Herthas Flak Area.

Table 3. Number of plaice of the different age- and size-groups caught per 30 minutes haul with fine-meshed otter seine in the Aalbæk Bay—Herthas Flak Area, August—September 1929.

Depth ms.	Stat. No.	Date	Age-Groups					Size-Groups, cms.						Total
			I	II	III	IV	V	5—9	10—14	15—19	20—24	25—29	30—34	
6.5	1670	10/9	14	10	..	..	..	2	9	3	7	3	..	24
7	1640	9/8	16	4	..	..	..	..	7	9	3	1	..	20
7	1669	10/9	234	74	..	..	..	6	108	118	68	8	..	308
12	1671	10/9	132	35	..	..	..	..	91	44	28	4	1	167
15	1668	10/9	39	9	1	..	..	..	31	8	9	1	..	49
17	1673	10/9	47	43	2	..	..	1	34	15	39	3	..	92
17	1674	11/9	40	28	2	..	..	..	30	12	22	6	..	70
21	1672	10/9	10	27	1	..	..	..	9	3	23	3	..	38
21	1667	9/9	..	..	..	..	..	..	..	..	..	..	..	0
23	1639	9/8	5	..	..	..	..	..	2	3	..	..	..	5
23	1680	12/9	9	..	..	..	..	..	6	3	..	..	..	9
24	1675	11/9	3	2	1	..	..	..	2	1	1	2	..	6
24	1679	11/9	2	11	2	..	..	..	2	1	7	4	..	15
25	1677	11/9	..	4	..	..	..	..	..	..	2	2	..	4
26	1676	11/9	..	..	..	..	..	..	..	..	..	..	..	0
27	1681	12/9	5	2	1	..	..	..	4	1	2	1	..	8
28	1678	11/9	..	1	1	..	..	..	..	..	1	1	..	2
29	1672	12/9	..	2	..	..	..	..	..	..	2	..	..	2
30	1641	10/8	..	1	..	..	..	..	..	..	..	1	..	1
31	1683	12/9	..	9	1	1	..	..	..	..	2	9	..	11
33	1685	12/9	..	2	..	..	..	..	..	..	2	..	..	2
34	1684	12/9	..	1	..	..	..	..	..	..	1	..	..	1

Table 4. The catches of plaice of the different age- and size-groups in the area Aalbæk Bay—Herthas Flak, July 1927, July 1928, and August—September 1929.

Depth zone	5—15 ms.	15—25 ms.	25—35 ms.	> 35 ms.
Number of stations	19	21	19	9
Mean of total number caught per 30 min. hauls in 1927, 1928, and 1929	161	52	9	4
Total number caught per 30 min. hauls in each of the years 1927, 1928, and 1929	158—195—104	52—85—32	9—12—4	2—6—?
Percentage of age-groups I—II	87	93	83	52
Percentage of age-groups IV and upwards	0.8	0.0	2	6
Percentage of plaice < 20 cm.	68	66	36	36
Percentage of plaice < 25 cm.	97	97	86	66
Percentage of plaice > 26 cm.	1	1	12	33
Percentage of plaice > 27 cm.	0.7	0.8	8	30
Percentage of plaice > 30 cm.	0.1	0.3	1	15

The Shallows to the north and north-west of Læsø. In the area to the north and north-west of Læsø as far as the deep channel, the Læsø Flak, 6 fishing experiments were carried out in 1928 and 1929 in depths of from 5 to 28 metres. As only 26 plaice in all were caught and examined the fishing experiments only give a very unreliable picture of the stock in this area. They do however show that the plaice stock here was much thinner in these years than the stock in the area Aalbæk Bay—Herthas Flak. Only 8 plaice were caught on an average per 30 minutes' haul. No plaice older than the III-Group were found at the fishing experiments, and this area may also, in accordance with the results of earlier fishing experiments[1]), be considered a pronounced nursery ground for young plaice.

2. The middle and southern Kattegat.

In the Kattegat to the south of the line Stensnæs—Læsø it was only in a few localities and only in depths of under 10 metres that the density of the plaice was about the same as in the area Aalbæk Bay—Herthas Flak (cp. Fig. 1). Such a locality where the density was great was thus found at Hals. Within 5 sea-miles from Hals 438 plaice in all were caught at 7 stations at the fishing experiments with the tog in 1927, 1928, and 1929 in depths up to 10 metres, or a mean number of 63 plaice per 30 minutes' haul. All these plaice belonged to the I- or II-Groups.

[1]) cp. A. C. Johansen: Contribution to the Biology of the Plaice. III. On the variation in frequency of young Plaice in Danish Waters in 1902—07. Medd. f. Komm. f. Havunders. Ser. Fiskeri. Bd. III, No. 4, 1908.

As the distance from the coast increases the density greatly decreases.

Topographically the middle and southern Kattegat falls naturally into the following divisions:

a) The Shallows up to the 20 metre line in the western Kattegat.
b) The deep easterly and south-easterly part of the Kattegat.
c) The Shallows up to the 20 metre line to the north of Sealand.

It will be seen from the Charts, Fig. 1, that the plaice are very dense only in the western part of the first-mentioned area until approximately a line from the western point of Læso to Fornæs, and that according to the density of the plaice within this region we can distinguish between an area along the coast of Jutland where the depth is less than 10 metres and an area where the depth exceeds 10 metres.

In addition to these areas we shall discuss both the Sound and the Isefjord.

It may be mentioned here with reference to the applicability of the material that the fishing experiments carried out in the Kattegat to the east of the line Læsø—Fornæs, were as is apparent from the Charts, fairly comprehensive and afforded reliable data as to the density of the plaice stock in these areas. On the other hand the number of plaice caught at these fishing experiments was so small, especially in the Shallows in the western Kattegat to the east of the line from the western point of Læsø to Fornæs and in the south-easterly part of the Kattegat, (in all 12 individuals) that the information afforded as to the size and age composition of the plaice stock is very unreliable and therefore does not figure in Table 5.

The number of the plaice in the different age- and size-groups found in these areas is given in Table 5 below.

It will be seen that the number of plaice caught per 30 minutes' haul in the two areas to the west of the line from the western point of Læsø to Fornæs is on an average 20—100 times greater than in the Shallows in the Kattegat to the east of this line and in the deeper south-easterly portion of the Kattegat. The average density in the 5—10 metres' zone is half as great as the density in the 15—25 metres' zone in the area Aalbæk Bay—Herthas Flak; in the rest of the area, deeper than 10 metres, to the west of the line from the western point of Læsø to Fornæs the density is equal to that in the 25—35 metres' zone in the area Aalbæk Bay—Herthas Flak, i. e. in both areas the density is great.

Both of these areas to the west of the line Læsø—Fornæs are important nursery grounds where about 90 % of the plaice are smaller than 25 cm. and where the number of plaice over the Danish minimum, 25.7 cm., only constitute 10 % of the stock.

The Shallows north of Sealand up to 20 metres' depth and the eastern part of the Shallows in the western Kattegat to the east of the line Læsø—Fornæs have been, at all events in these years, unimportant as nursery grounds. Most of the plaice caught were small and young, but the density was low.

The deep part of the Kattegat, exceeding 20 metres in depth, is, in contrast to the Shallows, an area where the larger plaice predominate. At the fishing experiments in this area no plaice smaller than 20 cm. were caught.

In the areas less than 20 metres in depth, the I- and II-Groups were by far the

Table 5. Number of plaice caught with eel-tog in the different parts of the Kattegat S. of the line Stensnæs—Læsø—Nidingen.

Area	The Shallows in the western Kattegat			Deeper parts of the Kattegat > 20 m.[1])	The Shallows along the coast of Sealand 5—20 m.
	Along the coast of Jutland 5—10 m.	W. of Læsø Fornæs 10—22 m.	E. of Læsø Fornæs 10—20 m.		
Number of stations	25	14	16	32	9
Date for Fishing experiments	May-Sept.	May-Sept.	May-Aug.	May-Aug.	Apr.-Oct.
Mean Total number per 30 min. haul	24	7	0.2	0.3	1
Mean Total number per 30 min. haul in the years 1927, 1928, and 1929 respectively	24—25—22	6—2—24	0.4—0.0—0.3	0.4—?—0.2	1.3—1.0—0.7
Percentual number of age-groups I-II	92	97	..	..	..
Percentual number of age-groups IV, V, and VI	0.2	0.0	..	..	..
Percentual number of plaice < 20 cms.	46	63	..	..	..
Percentual number of plaice < 25 cms.	85	89	..	..	..
Percentual number of plaice > 26 cms.	7	7	..	..	..
Percentual number of plaice > 27 cms.	5	7	..	..	..
Percentual number of plaice > 30 cms.	2	1	..	..	..

[1]) Including 1 station S.E. of Hasteens Ground at 19 m. depth.

most numerous; in the deeper part of the Kattegat where the depth exceeds 20 metres these age-groups formed only a small proportion of the stock, whilst the plaice older than the III-Group constituted the majority.

The Sound. In the Sound, which is here taken as extending from the line Helsingør—Helsingborg to the line Dragør—Limhamn, fishing experiments with the tog were carried out in 1927 and 1929 at 11 stations in all. In addition a material caught in commercial fishing operations has been included in the investigation.

As will be seen, the material from the fishing experiments is too small to enable us to judge the composition of the plaice stock, but it affords some indications.

In depths exceeding 10 metres 20 plaice were caught at 10 stations or 2 plaice per 30 minutes' haul. 16 of the plaice belonged to the IV-Group and upwards, all being over 27 cm. in length, 7 being even over 40 cm.

Whilst at the numerous fishing experiments with the tog in the Kattegat and Belt Sea only 9 plaice in all were caught of the V-Group and none older (a few plaice being, however, also caught whose otoliths could not be determined), 7 plaice of the V-Group and older were caught at the ten fishing experiments in the Sound in 1927 and 1929.

Plaice caught in commercial fishing operations (with plaice nets) at depths of 12—20 metres on Febr. 24th 1930 in the Sound W.N.W. of Hveen were furthermore

subjected to investigation. In the sample examined comprising 118 individuals 70 % exceeded 30 cm. in length. Samples of plaice comparable with these were obtained from the Belt Sea, where from July 1929 till January 1930 catches from the commercial fishery (otter seine and Danish seine) were investigated at a number of places, the depths being the same as in the Sound. In these samples only 37 % of the plaice caught were found to be over 30 cm. in length (555 plaice in all being examined).

There are thus proportionately larger and older plaice in this area than in the others in which investigations have been carried out. The stock seems in great measure to resemble that in the deep easterly and south-easterly Kattegat with respect to size and age composition.

The Isefjord. In the Isefjord 16 fishing experiments in all were carried out in 1928 and 1929 throughout the whole area (cp. Charts, Figs. 1—5). 74 plaice in all were caught; the Table below shows to what size and age-groups they belonged:

Table 6. Number of plaice of various age- and size-groups caught with fine-meshed otter seine in the Isefjord, Aug.—Oct. 1928 and 1929, depths 6.5—11 m.

Number of stat.	Average Total per 30 min. haul	Age-group I-II, % of total	Age-group IV and above, % of total	Percentage of plaice				
				< 20	< 25	> 26	> 27	> 30 cms.
16	5	96	4	51	89	8	5	3

It will be seen that the size and age composition of the stock in the Isefjord approximates very closely to that in the part of the Shallows in the western Kattegat which lies to the west of the line from the western point of Læsø to Fornæs, but that the average density of the plaice in the Isefjord was rather low. It seems to have been lower than the average density in that part of the above-mentioned area which lies outside the 10 metre line.

The Isefjord is thus a pronounced nursery ground and, as we shall see later, the separate age-groups have here attained extremely great average lengths. Partly by reason of the rather small size of the area and partly by reason of the comparatively low density it nevertheless affects only to a lesser extent the renewal of the plaice stock in the Kattegat.

The Belts. 128 fishing experiments in all, with an aggregate trawling time of 54 hours 15 minutes, were carried out in the Belts outside the 5 metre line in 1927, 1928, and 1929. 472 plaice were caught at these stations and examined, of which 399 were caught in the northern Belt Sea and Great Belt, and 73 in the Smaalandshavet.

Only at 4 localities within the Belts was any considerable density of plaice found, viz.:—

in Kerteminde Bay, especially in 1927,
in Baaring Vig in 1927,
at 1 station in Sejrø Bay in 1927,
at 1 station in the Smaalandshavet in 1928.

At all other stations in the area only quite a few or no plaice were found (cp. Charts). The results of the fishing experiments at the three first-mentioned localities are shown below in Table 7.

Table 7. Number of plaice of the different size- and age-groups caught per 30 minutes' haul at 3 localities in the Belt Sea.

Locality	Year	Depth ms.	Date	Haul in min.	Total numb.	Age-Groups				Size-Groups, cms.							
						I	II	III	IV	5—9	10—14	15—19	20—24	25—29	30—34	>26	>27
Kerteminde Bay	1927	12	30/5	20	60	..	60	..	..	..	4	33	22	..	..	..	..
		12	18/6	30	44	1	43	..	..	1	2	21	20	..	..	..	..
		13	30/5	30	4	..	3	1	..	..	..	1	1	1	1	2	2
		13	13/6	30	7	..	7	..	..	..	5	1	..	1	..	1	1
		18	30/5	30	4	..	3	..	1	..	..	..	2	2	..	2	1
	1928	4	20/6	15	30	6	6	16	..	..	2	10	18	..	..	..	..
		13	30/7	30	1	..	..	..	1	..	..	..	..	..	1	1	1
		13	30/7	30	4	..	1	3	..	..	..	..	1	3	..	..	..
	1929	5	8/7	20	16	6	10	..	..	..	..	9	6	1	..	..	..
		11	8/7	15	2	..	2	..	..	..	..	..	1	..	..	..	..
		18	8/7	20	0	..	..	..	..	..	..	..	..	..	..	..	..
Baaring Vig	1927	2.8	14/6	30	39	1	38	..	..	..	1	23	15	..	..	..	..
		13.5	14/6	30	22	..	21	..	1	..	6	10	5	1	..	..	..
	1928	12.5	19/5	30	0	..	..	..	..	..	..	..	..	..	..	..	..
		15	19/5	30	0	..	..	..	..	..	..	..	..	..	..	..	..
Sejrø Bay	1927	14	17/6	30	113	8	105	..	..	..	22	71	20	1	..	..	..

Both in 1928 and 1929 the plaice stock in the Smaalandshavet outside the 5 metre line seems to have contained a proportionately larger number of plaice of the two youngest age-groups, i. e. of the 0- and I-Groups in 1928 and 1929 respectively, than was found on an average in corresponding depths in the other parts of the Belts.

The number of fishing experiments carried out in this area was, however, so small that this apparent peculiarity in the Smaalandshavet does not greatly affect the result which we obtain by calculating the mean number of plaice belonging to the different size and age groups in the Belts. The stations in the Smaalandshavet are thus taken together in Table 9 with the stations in the northern Belt Sea and Great Belt.

The stations in the Belts, where considerable numbers of plaice were caught per 30 minutes' haul, all lie in depths less than 15 metres (up to 14 metres).

389 plaice were caught at 74 quantitative fishing experiments in depths between 5 and 15 metres, and 83 plaice at 54 fishing experiments in depths exceeding 15 metres.

If we calculate the number of plaice of the same size- and age-groups which we have considered in the areas discussed above we obtain the figures given in the Table below.

We see from Table 8 that those parts of the Belts where the depths are less than 15 metres are pronounced nursery grounds for young plaice, which in respect to the size-

Table 8. Number of plaice of various age- and size-groups caught by quantitative hauls with fine-meshed otter seine in the northern Belt Sea, the Great Belt and the Smaalandshavet between 5 and 15 m., between 15 and 25 and below 25 m.

Depth zone	5—15 metres	15—25 metres	Above 25 metres
Number of stations	74	38	16
Date for fishing experiments	May—July	May—Oct.	May—Aug.
Mean of Total number caught per 30 min. haul in 1927, 1928, and 1929	7	2	2
Total number caught per 30 min. hauls in each of the years 1927, 1928, and 1929	12—5—2	2—1—3	3—2—?
Percentage of age-groups I—II	79	71	35
Percentage of age-groups IV and upwards.	1	11	16
Percentage of plaice $<$ 20 cm.	67	38	16
Percentage of plaice $<$ 25 cm.	86	43	45
Percentage of plaice $>$ 26 cm.	11	42	52
Percentage of plaice $>$ 27 cm.	8	38	43
Percentage of plaice $>$ 30 cm.	2	38	35

and age-composition of the stock greatly resemble that part of the Shallows in the western Kattegat which lies to the west of the line from the western point of Læsø to Fornæs, but that the density of the plaice is on an average lower and fluctuates very greatly from year to year.

Those parts of the Belts where the depths are greater than 15 metres generally have a very much more scattered plaice stock than those parts where the depths are less than 15 metres, and the larger plaice constitute here a proportionately larger part of the stock. Those exceeding 26 cm. thus constituted here about half the stock. Those under 20 cm. in length constituted less than one sixth of the stock in depths greater than 25 metres.

III. Size of Plaice of the different Age-Groups in the Period 1927—1929.

If we consider a definite locality we find that in the course of the year changes take place in the average lengths of the plaice of the different age-groups by reason partly of their growth, partly of their migrations, and partly of the removal by the fishery of a large number of the plaice which are over a certain size. In considering the lengths of the different age-groups it is therefore necessary to keep the investigations in each single month separate.

In the following we shall take separately the same areas which have been discussed in the foregoing. The results from the different areas are given below in tabular form. The mean length of plaice of any age group is arrived at by calculating the mean length

of the total number of plaice caught at the fishing experiments in the area in question. All the lengths are rounded off downwards to the nearest whole centimetre and 0.5 cm. must therefore be added to give the real lengths.

1. The Mean Lengths of the Age-Groups in the Area Aalbæk Bay—Herthas Flak, and a Comparison with the Mean Lengths in other Areas.

a) The area Aalbæk Bay—Herthas Flak.

In Tables 9 and 10 are shown the mean lengths of the age-groups I—IV in July 1927 and 1928 and in September 1929 respectively.

Table 9. Average lengths of plaice of the different age-groups in the area Aalbæk Bay—Herthas Flak, July 1927 and 1928. (The numbers of plaice examined are given in brackets).

Age-Group	I-Group			II-Group			III-Group			IV-Group		
Sex	♂	♀	♂+♀	♂	♀	♂+♀	♂	♀	♂+♀	♂	♀	♂+♀
5—15 m.	11.3 (326)	11.3 (354)	11.3	18.5 (574)	18.5 (745)	18.5	22.1 (93)	22.6 (106)	22.4	23.5 (6)	25.0 (14)	24.6
15—25 m.	11.9 (158)	11.9 (138)	11.9	18.8 (596)	18.5 (692)	18.6	21.8 (33)	22.0 (31)	21.9	..	..	..
25—35 m.	11.9 (25)	11.4 (18)	11.7	19.3 (160)	19.1 (162)	19.2	21.7 (7)	23.0 (7)	22.5	..	29.2 (2)	29.0
> 35 m. .	13.7 (3)	..	13.7	19.9 (10)	18.5 (8)	19.2	26.1 (8)	25.0 (8)	25.6	..	34.0 (1)	34.0

Table 10. Average lengths of plaice of the age-groups I—III in the area Aalbæk Bay—Herthas Flak, Sept. 1929. (The numbers of plaice examined are given in brackets).

Age-Group ..	I-Group			II-Group			III-Group		
Sex	♂	♀	♂+♀	♂	♀	♂+♀	♂	♀	♂+♀
5—15 m....	14.4 (158)	13.8 (121)	14.2	22.8 (45)	22.0 (41)	22.4	..	30.0 (1)	30.0
15—25 m....	13.2 (73)	13.9 (82)	13.6	22.1 (70)	21.6 (51)	21.9	25.6 (9)	..	25.6
25—35 m....	13.0 (4)	10.0 (2)	12.0	23.2 (13)	24.5 (8)	23.7	29.0 (1)	27.5 (2)	28.0

Both in July and September only a slight tendency can be shown to exist towards an increase in the average lengths of the age-groups as the depth increases up to the 35 metre line. The average lengths of these age-groups for all depths from 5 to 35 metres are given in Table 11.

It will be seen that the average lengths of the II- and III-Groups of plaice were greater in September 1929 than the average lengths of the following age-groups, i. e. the III- and IV-Groups respectively, at the July fishing experiments. The fishing experiments are so comprehensive that we may assume that this is an actual fact. These

Table 11. Average lengths of the age-groups I—III in the area Aalbæk Bay—Herthas Flak. Depths 5—35 metres. (The numbers of plaice examined are given in brackets).

	I-Group			II-Group			III-Group		
Sex	♂	♀	♂+♀	♂	♀	♂+♀	♂	♀	♂+♀
July 1927-28	11.3 (509)	11.4 (510)	11.4	18.9 (1330)	18.7 (1599)	18.8	21.9 (133)	22.5 (144)	22.2
Sept. 1929 ..	14.0 (235)	13.8 (205)	13.9	22.4 (128)	22.1 (100)	22.3	25.9 (10)	28.3 (3)	26.5

changes in the average lengths possibly could be ascribed to different growth conditions in 1929 and in 1927 and 1928, but as the migrations of the plaice afford a natural explanation (cp. p. 33) it is natural to suppose that these migrations are the essential cause of the changes.

b) Comparison between the average lengths of the age-groups in the area Aalbæk Bay—Herthas Flak and in other nursery grounds for the North Sea race of plaice.

It is very interesting to compare the average lengths of the different age-groups in the area Aalbæk Bay—Herthas Flak with the average lengths in the southern Horns Reef area, because the latter is part of the most important nursery ground for the North Sea plaice while the area Aalbæk Bay—Herthas Flak is the most important nursery ground for the Kattegat plaice (cp. Section II in this paper). It is the same race of plaice which is found in both areas.

Table 12. Average lengths of the age-groups 0—IV in the southern Horns Reef area (cp. Table 11).

	1905[1]) Sept.—March 5—24 m.	1922—27[2]) Sept.—March 10—40 m.
0-Gr.	7 — 8 cm.	6.5— 8.5 cm.
I-Gr.	13 —14 -	12.5—14.5 -
II-Gr.	18.5—20 -	15.5—19.5 -
III-Gr.	24 —25.5 -	19.5—22.5 -
IV-Gr.	?	22.5—24.5 -

The average of any given age-group is thus 1—4 cm. greater in the area Aalbæk Bay—Herthas Flak than in the southern Horns Reef area.

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[1]) A. C. Johansen: Bericht über die dänischen Untersuchungen über die Schollenfischerei und den Schollenbestand etc. Medd. f. Komm. f. Havunders. Ser. Fiskeri. Bd. III, No. 8, 1910.

[2]) Aage J. C. Jensen: An Investigation of the stock of plaice in the southern Horns Reef Area in the years 1925 and 1927. Medd. f. Komm. f. Havunders. Ser. Fiskeri. Bd. VIII, No. 6, 1928. Tables 22, 23, 27, 28.

Another region where the density of the young plaice is very great and from which the stock in large areas is recruited, although this is effected partly by the transplanting of young plaice, is Nissum Broad. At the fishing experiments in 1927 the following mean lengths were found for this area:

Table 13. The mean lengths of plaice of the age-groups I—IV in Nissum Broad, 1927, compared with the mean lengths in the area Aalbæk Bay—Herthas Flak.

	Nissum Broad 1927		Aalbæk Bay—Herthas Flak 1927—29	
	April	July	July	Sept.
I-Gr.	6.9	9.4	11.4	13.9
II-Gr.	12.7	14.5	18.8	22.3
III-Gr.	19.5	20.5	22.2	26.5
IV-Gr.	22.4	24.3		

It will be seen that also in this area the plaice of the same age group are smaller than in the area Aalbæk Bay—Herthas Flak.

It is noteworthy that the average lengths of the plaice of the different age-groups in the area Aalbæk Bay—Herthas Flak are greater than the average lengths of plaice of the same age-groups in other important areas from which the market plaice of the North Sea race are recruited.

c) The Shallows to the north and north-west of Læsø.

The number of plaice caught in this area (mainly in Sept. 1929) was, as mentioned on page 18, fairly small. The average lengths of the age-groups were as follows:

Table 14. Average lengths of plaice caught in the Shallows N. and N.W. of Læsø. (The numbers of plaice are given in brackets).

I-Group		II-Group		III-Group
♂	♀	♂	♀	♂
17.4 (9)	18.5 (4)	26.7 (4)	27.0 (4)	24.0 (1)

In accordance with the lower density the average lengths of the plaice of the different age-groups are much greater than in the area Aalbæk Bay—Herthas Flak.

2. The Mean Lengths of the Age-Groups in the middle and southern Kattegat.

a) The Shallows in the western Kattegat to the west of the line from the western point of Læsø to Fornæs.

We possess comprehensive data from the years 1927—1929 collected in the western part of the middle Kattegat, west of the line from the western point of Læsø to For-

næs, for the purpose of determining the mean lengths of the plaice of the different age-groups in this area.

But, despite the fact that 584 plaice in all were caught at the quantitative fishing experiments in this area outside the 5 metre line, great difficulties stand in the way of determining the average lengths by reason of the mixed character of the plaice stock. As we know from A. C. Johansen's work[1]), plaice of both the North Sea and the Baltic races are found in this area. Samples even from adjacent localities can therefore give contradictory results as regards the average lengths of the different age-groups, especially in the case of the II-Group and older plaice. If we thus consider the two samples of plaice of the II-Group which comprise the most individuals, both being taken near Hals in 1927, on May 4th and July 6th respectively, we find that their mean lengths are 22.5 cm. (111 individuals) and 22.3 cm. (59 individuals) respectively. If we take all the material from May together and in the same way all the material from July we obtain the same result, so it might seem as if the plaice had not increased in length during this interval, which, however, has presumably been the case. As will be shown below (p. 34), the increase in the average lengths of the different age-groups in this area in the course of the summer months was probably not very great but we can nevertheless assume that the average lengths increased to some extent.

The material is not large enough for us to distinguish between the depth zones inside and outside the 10 metre line. There does not, however, seem to be any material difference between the average lengths of an age-group when we consider the II-Group and older plaice in these two depth zones. Thus the average length of plaice of the II-Group caught in May in the depth zone 5—10 metres along the coast of Jutland was 22.4 cm. (135 individuals), and in the depth zone 10—22 metres it was 22.5 cm. (42 individuals).

Table 15. Average lengths of plaice of age-groups I—III in the area W. of the line from the western point of Læsø to Fornæs, 5—22 metres, in 1927, 1928, and 1929. (The numbers of plaice examined are given in brackets).

Age-Group ..	I-Group			II-Group			III-Group		
Sex	♂	♀	♂+♀	♂	♀	♂+♀	♂	♀	♂+♀
May.....	..	..	..	22.4 (106)	22.6 (71)	22.5	..	33.3 (3)	33.3
June-July...	13.2 (44)	13.0 (48)	13.1	22.1 (56)	23.4 (46)	22.7	24.1 (17)	27.1 (12)	25.4
Aug.-Sept. ..	15.8 (88)	15.5 (68)	15.7	21.6 (11)	23.8 (11)	22.7	..	29.0 (1)	29.0

Furthermore, two samples of plaice were examined which had been caught in commercial fishing operations to the north of Gjerrild (Djursland) in the spring of 1928. The average lengths are shown in the Table below.

[1]) A. C. Johansen: loc. cit. 1910 p. 122 et seq. and by the same author: Some characters of the Baltic plaice which have changed during the last decennaries. Rapports. Bd. LIV, 1929.

Table 16. Average lengths of plaice of age-groups III and IV, caught in commercial fishing operations N. of Gjerrild. (The numbers of plaice examined are given in brackets).

Date of catch	Depth in metres	III-Group			IV-Group
		♂	♀	♂+♀	♀
11. Apr. 1928	4—5	28.6 (55)	29.4 (39)	28.9	40.0 (2)
12. Apr. 1928	9—10	30.3 (43)	31.8 (54)	31.2	35.7 (3)

It will be noticed that the average length of the III-Group is 2 cm. less in 4—5 metres' depth than in 9—10 metres' depth. The average length of the III-Group in 4—5 metres' depth, as calculated here, is undoubtedly too high since a number of plaice below 25 cm. were able to escape through the meshes of the fishing implements. The average length of the III-Group in 9—10 metres' depth seems on the other hand to be virtually correct.

The average length of the III-Group in the two samples is 6—8 cm. greater than the average length of the II-Group in the preceding summer (Table 15), which must be ascribed chiefly to the migrations of the plaice referred to above (see also p. 34).

b. The Sound and the easterly and south-easterly deep part of the Kattegat.

In the remaining areas of the middle and southern Kattegat and in the Sound the number of plaice caught and examined at the quantitative fishing experiments was small, but a fairly large number of commercial plaice caught in the Sound were also examined. In the table below appears the lengths of the II—VI age-groups of plaice caught in the Sound drawn together with the plaice caught at the fishing experiments in the middle and southern Kattegat in depths exceeding 20 metres.

All the plaice found in these areas have a very great average length in relation to their age (cp. Table 17) and it is therefore a natural procedure to take all these areas together in order to determine the average lengths of the age groups from as large a material as possible. Taking the Sound and the deep

Table 17. Average lengths in the summer months of the different age-groups in the Sound at greater depths than 10 metres, and in the Sound together with the south-eastern Kattegat at greater depths than 20 m. (The numbers of plaice examined are given in brackets).

Age-Group	II	III	IV	V	VI
Sound > 10 m.	29.0 (2)	37.0 (2)	35.8 (8)	38.8 (4)	
Sound > 10 m., and S.E. Kattegat > 20 m.	27.5 (4)	33.7 (3)	35.3 (11)	38.2 (5)	42.0 (1)

southern and south-eastern part of the Kattegat together is in fact quite natural since the size and age compositions of the stock in the latter area greatly resemble those in the Sound (see p. 21).

All these measurements are in close agreement, and also agree with the measurements of the commercial plaice caught in the Sound W.N.W. of Hveen in Febr. 1930 (see Table 18).

It may therefore be assumed that the average lengths calculated are an expression for the average lengths of the age-groups over large parts of the south-eastern Kattegat and the Sound. The plaice stock in these regions is thus obviously recruited partly from the nursery grounds in the middle and western Kattegat.

Table 18. Mean lengths of plaice caught in commercial fishing operations W.N.W. of Hveen, Febr. 1930. Depth 12—20 metres. (The numbers of plaice examined are given in brackets). The race was determined by Dr. A. C. Johansen.

Age-Group	II-Group		III-Group		IV-Group	
Sex	♂	♀	♂	♀	♂	♀
Baltic plaice	29.9 (19)	30.3 (44)	31.7 (3)	32.6 (5)	29.5 (2)	40.4 (5)
All plaice	29.9 (19)	30.3 (44)	32.7 (4)	32.7 (6)	30.7 (3)	36.9 (29)

Isefjord. Fishing experiments were carried out in this area in the first few days of August 1928 and 1929 and on October 23rd, 1929. The following mean lengths for the age-groups I, II, and IV were obtained.

Table 19. Mean lengths of plaice caught in the Isefjord at the fishing experiments with fine-meshed otter seine in 1928 and 1929. (The numbers of plaice examined are given in brackets).

Age-Group	I-Group			II-Group			IV-Group		
Sex	♂	♀	♂+♀	♂	♀	♂+♀	♂	♀	♂+♀
1.-4. Aug. 1928—29	18.2 (29)	18.2 (23)	18.2	23.0 (1)	33.0 (1)	28.0	26.1 (1)	27.0 (1)	26.5
23. Oct. 1929	23.3 (6)	23.7 (7)	23.5	..	29.7 (3)	29.7	..	..	..

Of all nursery ground areas it is in the Isefjord that the different age-groups of plaice have the greatest average lengths. The stock here is, as mentioned on p. 21, a pronounced young fish stock, but, in comparison with the young fish stocks investigated in the Kattegat, the area was very thinly populated. The great average length of the plaice in the Isefjord thus corresponds to a comparative lack of competition for food.

3. The Mean Lengths of the Age-Groups in the Belts.

In the northern Belt Sea, the Great Belt, and Smaalandshavet, if we take together the whole material for the various times in which fishing experiments were carried out, we find the average lengths for age-groups I—III to be as shown in Table 20.

Table 20. Average lengths of age-groups I—III in the northern Belt Sea, Great Belt, and Smaalandshavet in the different months in 1927, 1928, and 1929.

Month	Year	Depth in m.	I-Group			II-Group			III-Group		
			♂	♀	♂+♀	♂	♀	♂+♀	♂	♀	♂+♀
9. May—19.	1927										
June	—28	5—33	10.3 (8)	12.8 (5)	11.3	18.3(154)	18.9(133)	18.6	25.2 (13)	30.2 (11)	27.5
8. July—12.	1928										
Aug.	—29	5—48	13.7 (29)	13.8 (21)	14.6	21.4 (6)	21.4 (10)	22.6	27.0 (4)	28.8 (5)	28.0
27. Sept.—5.											
Oct.....	1929	13—20	15.0 (1)	..	15.0	28.8 (6)	25.5 (8)	27.9	..	34.0 (1)	34.0

If we compare the above with Table 16, we see that the average length of age-group I at the same date is the same in the Belt Sea as in the nursery grounds in the western part of the middle Kattegat. On the other hand the II- and III-Groups in the Belt Sea seem to be smaller than the II- and III-Groups in the middle and southern Kattegat.

A comparison of the mean lengths in different parts of the extensive and diverse areas which have been taken together in Table 18 under the heading of the northern Belt Sea, Great Belt, and Smaalandshavet, can in consequence of the paucity of material only be undertaken for certain times and for age-group II. This comparison follows in Table 21.

Table 21. Mean length of age-group II in different parts of the Belts, May 9th—June 19th, 1927, and 1928, at depths of 5—15 metres. (The numbers of plaice examined are in brackets).

	♂	♀	♂+♀
The northern Belt Sea.....	17.9 (80)	18.0 (71)	17.9
Great Belt.....	18.3 (54)	19.3 (51)	18.8
Smaalandshavet.....	19.0 (5)	20.0 (1)	19.2

It will be seen that the average lengths, in any case of age-group II, increase towards the south. This is confirmed by an investigation of the material collected by the commercial fishery (cp. p. 31 and Table 23). The same was found to be the case in the first decade of this century, before the intensive fishery started, and was presumably

due, as A. C. Johansen points out, to differences in the natural growth conditions in the two areas[1]).

As regards the question of the renewal of the stock it is interesting to investigate whether the average lengths in the separate localities of the Belts, where a particularly large accumulation of plaice has been found, differ from the average lengths in other areas where the depths are similar.

We possess a very large sample from Kerteminde Bay for March 29th, 1927. The results of this investigation together with other analyses of plaice in Kerteminde Bay, Baaring Vig, and Sejrø Bay are shown in Table 22.

Table 22. Average lengths of age-groups I, II, and III in Kerteminde Bay, Baaring Vig, and Sejrø Bay at different times of the year in 1927—1929 at depths up to 15 metres.

Locality	Year and Date	Depth ms.	I-Group			II-Group			III-Group			IV-Group
			♂	♀	♂+♀	♂	♀	♂+♀	♂	♀	♂+♀	♂+♀
Kerteminde Bay	29/3 1928[2])	4—5	10.5 (4)	11.0 (1)	10.2	18.3 (19)	18.2 (26)	18.2	21.2(175)	21.3(226)	21.2	22.4 (27)
	30/5 1927	12—13	..	..	..	17.4 (21)	20.1 (22)	18.8	27.0 (1)	..	27.0	..
	13, 18/6 1927	12—13	9.1 (1)	..	9.0	18.9 (28)	18.3 (22)	18.6	..	..	..	..
	20/6 1928	4	14.0 (2)	17.0 (2)	15.5	..	22.0 (5)	22.0	20.8 (6)	21.0 (12)	20.9	..
	8/7 1929	5—11	15.0 (2)	16.5 (2)	15.8	19.7 (3)	22.6 (5)	21.5	..	..	..	..
	30/7 1928	13	..	..	..	21.0 (1)	..	..	26.0 (1)	25.5 (2)	25.7	30.0 (1)
Baaring Vig	14/6 1927	2.5—13.5	..	14.0 (1)	14.0	17.7 (25)	18.5 (34)	18.1	..	..	..	28.0 (1)
Sejrø Bay	17/6 1927	14	11.8 (4)	11.8 (14)	11.8	17.5 (55)	17.5 (50)	17.5	..	..	..	..

If we compare the average lengths shown in this Table with those given in Tables 20 and 21, we shall see that the average lengths in the most thickly populated parts of the young fish grounds in the Belt Sea are not materially lower than those of all the plaice caught at the same depths in the northern Belt Sea and Great Belt.

In addition to the plaice from the quantitative fishing experiments from the "Japetus Steenstrup" a number of plaice caught in commercial fishing operations were otolithed. Owing to the large meshes of the implements used, practically all the plaice under 25 cm. in length were able to escape, together with a number of plaice 26 cm. in length. The lengths determined in the samples of the plaice of the different age-groups are shown below in Tables 23 and 24.

At the investigations in the winter of 1929—1930 an increase in the lengths of the different age-groups from north to south was noted, similar to that shown in Table 21.

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[1]) A. C. Johansen: Om Rødspætten og Rødspættefiskeriet i Beltfarvandet. Skrifter udgivne af Komm. f. Havunders. No. 7, 1912. Table 5, p. 30 and p. 33.

[2]) In order to render the figures comparable with the other mean lengths, the age-groups are given as from April 1st, their category figure being raised by 1.

The age group II was also in these commercial samples most abundant, and the average lengths of this age-group at Samsø and Romsø are shown in Table 23.

Tabel 23. Average lengths of plaice of II-Group in the catches of the commercial fishery in the winter of 1929—1930.

Locality	Date	II-Group ♂	II-Group ♀
W. of Samsø	7. Jan.	28.7 (48)	31.6 (10)
N.E. of Romsø	6. Jan.	30.7 (40)	34.5 (6)

In Table 24 are shown both the average lengths of the different age-groups in March 1928 before the transplantation of plaice from Nissum Broad and the North Sea was commenced and the mean lengths in the winter of 1929—1930 after this transplantation had been carried out for two years.

Table 24. Average lengths of age-groups II—V in catches with the Danish seine and otter seine in the Belt Sea. (The numbers of plaice examined are given in brackets).

Locality	Date and Year	II ♂	II ♀	III ♂	III ♀	IV ♂	IV ♀	V ♂	V ♀
Dalby Bay	29. March 1928	27.5 (165)	30.0 (19)	28.8 (19)	30.5 (6)		30.1 (1)	32.0 (1)	
Samsø, Romsø	6.—7. Jan. 1930	29.6 (88)	32.7 (16)	32.4 (25)	36.0 (28)	33.7 (34)	36.9 (31)	34.8 (5)	37.0 (1)

It will be seen that the average lengths of all these age-groups were greater in 1930 than in 1928. Practically no plaice of the II- and III-Groups, many of the IV-Group (year-class 1925), and few of the V-Group of the fish found in the winter of 1929—1930 were transplanted. There seems therefore no evidence that the transplanting operations have caused any great change in the average lengths of the different age-groups, but the average lengths of the age-groups have on the whole steadily increased concurrently with the constant thinning out of the stock, which has taken place despite the addition of young plaice by transplantation and which is plainly indicated by the constantly decreasing fishery yield[1]).

If we compare the average lengths of the plaice caught with the tog with those of the plaice caught in commercial fishing operations, we see that as regards the IV-Group and older plaice we can assume that the average lengths of the age-groups of the plaice caught in commercial fishing operations have been correctly computed, but that a considerable number of the smaller plaice of the younger age-groups have escaped, so that their average lengths are put too high.

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[1]) A. C. Johansen, 1928, loc. cit.

4. The yearly Changes in the Average Lengths of the different Age-Groups in the Kattegat and in the Belts.

Fig. 8 below shows the average lengths in the different areas.

It must be pointed out that these curves only show the average lengths of the plaice at the different times of the year and do not show their growth. Their lengths in any given area are determined partly by their growth, partly by the immigrations and emigrations which take place to and from the area, and partly by the effect of the fishery.

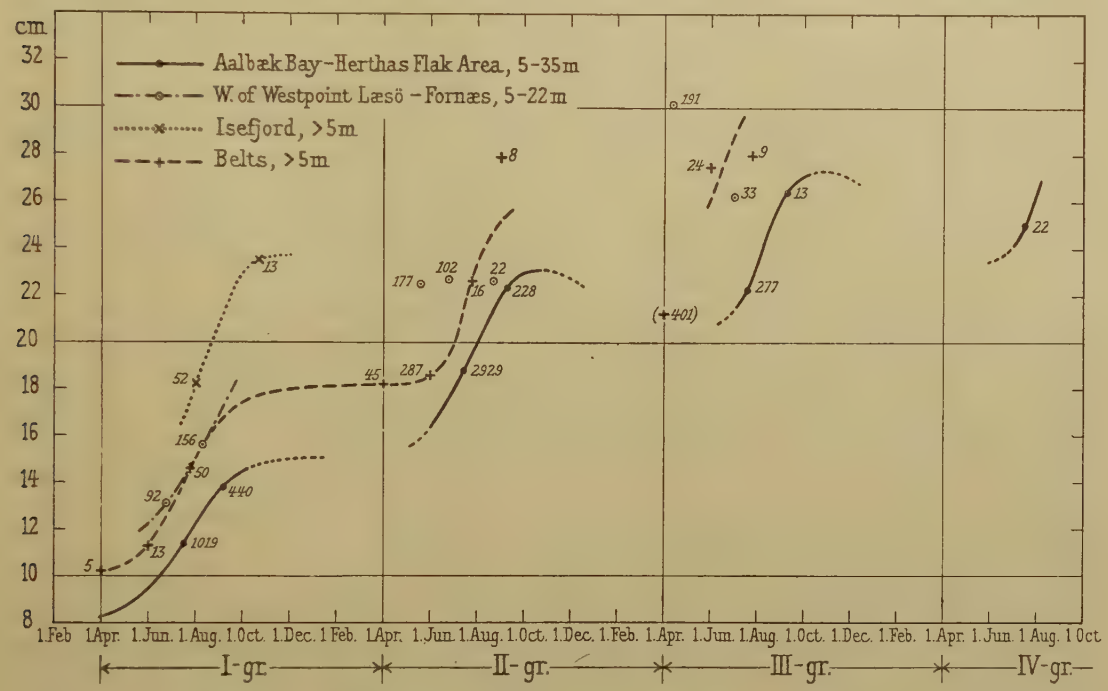

Fig. 8. Average length of the plaice of age-groups I—IV in the different months in the various areas.

The changes in the average lengths of the age-groups with the time of year accord fully with what one would naturally expect especially from the growth of the plaice and the migrations they undertake.

It will thus be seen that in the area Aalbæk Bay—Herthas Flak the average length of an age-group in the spring months and the early summer is less than the average length of the previous age-group in the autumn (cp. p. 25). This is a natural consequence of the interchange of plaice between the northern Kattegat and the Skagerak. It is namely chiefly in the spring that an immigration takes place round the Skaw into the Kattegat of small immature fish belonging to different age-groups[1]), whilst for a large part of the

[1]) A. C. Johansen: Ueber die Schollenfischerei im Kattegat und die Mittel sie zu heben. Rapports et Procès-Verbaux. Vol. V, 1906, p. 77 and A. C. Johansen: Contributions to the biology of the plaice. II. The Marking and transplantation experiments with Plaice in the years 1903—1906. Medd. f. Kom. f. Havunders. Ser. Fiskeri. Bd. II, No. 5, 1907. e. g. Table V.

winter and spring the larger mature fish of each age-group emigrate. Moreover in the autumn and winter a migration takes place into the area, or rather through it, of mature fish which have grown up outside the area Aalbæk Bay—Herthas Flak, partly in the eastern and southern Kattegat[1]), the age-groups of which have greater mean lengths than those of the plaice which have grown up in the area Aalbæk Bay—Herthas Flak. These migrations raise the average lengths in the autumn and lower them in the early summer.

The seasonal movements of the immature plaice between the shallower and deeper water do not to any great extent alter the average lengths of the age-groups in this area, as they are practically uniform right out to depths of 30—40 metres.

The removal by the plaice fishery of a number of individuals, mainly the large ones, in the course of the winter when the growth of the plaice is very slight is a partial cause of the average lengths being smaller in the spring than in the autumn.

In the nursery grounds in the middle Kattegat to the west of the line Læsø—Fornæs, the migrations of the plaice have the effect both of raising the mean lengths of the different age-groups in the early summer months and of lowering them in the autumn. An immigration takes place namely in the spring into the area from the deep south-eastern Kattegat of the plaice that have wintered there[2]), and as all the investigations of the plaice stock in this area has proved, at all events for the main part, that the stock comprise only the largest individuals of each age-group this raises the average lengths of the age-groups in the nursery grounds in the Shallows of the western Kattegat in the early summer. The large plaice, however, begin to emigrate again from June—July and are replaced to some extent in the shallower parts of the Shallows by plaice which migrate outwards from the coastal area.

The presence of a proportionately large number of mature individuals among these age groups[3]) is a partial cause of the average lengths of the II- and III-Groups in this area being rather small in the autumn (in Sept.—Oct. 1905 they were even smaller here than in the northern Kattegat). As has been pointed out by A. C. Johansen, the immature individuals are on an average considerably smaller than the mature fish of the same age-group.

These mature plaice emigrate in the course of the autumn and winter, from October until about March, from these areas of the Kattegat; the mature plaice of the North Sea race migrate into the northern Kattegat, Skagerak, and North Sea, whilst the mature plaice of the Baltic race migrate into the southern or south-easterly Kattegat[4]).

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[1]) A. C. Johansen: 1907. loc. cit. e. g. Tables II, III, and IV.

[2]) A. C. Johansen: Contributions to the biology of the plaice. II. The marking and transplantation Experiments with plaice in the Danish waters in the years 1903—1906. Medd. f. Komm. f. Havunders. Ser. Fiskeri. Bd. II, No. 5, 1907. (especially Table IV) and A. C. Johansen: Om Rødspætten og Rødspættefiskeriet i Beltfarvandet. Skrifter udg. af Komm. f. Havunders. No. 7, 1912, p. 77.

[3]) A. C. Johansen: loc. cit. 1906, p. 99.

[4]) A. C. Johansen: loc. cit. 1907, p. 84 et seq.

IV. Comparison between the Average Lengths of the Age-groups during the Period 1927—1929 and the Average Lengths in former Years.

The investigations of the average lengths of the age-groups in former years afford a material, comparable with that obtained from the investigations in the period 1927—1929, which enables us to judge whether the average lengths of the separate age-groups have altered during the intervening years.

In addition the average lengths in the area Aalbæk Bay—Herthas Flak in each of the years 1927, 1928, and 1929 will be compared.

It has been shown previously that in the Belt Sea the average lengths of the different age-groups have increased at the same time that the stock has been thinned out by the intensive plaice fishery which started in about 1910[1]).

1. The Variations in the Average Lengths of the Age-groups from Year to Year in the Area Aalbæk Bay—Herthas Flak.

In the foregoing we have taken together the material from all the three years in which comprehensive fishing experiments have been carried out in order to obtain as reliable an expression as possible for the average lengths of the plaice. In this area, however, in contrast to the other areas investigated, the material is comprehensive enough to allow of our investigating the variations from year to year in the average lengths of the age groups.

Table 25. The average lengths of the plaice of the age-groups I—III in the area Aalbæk Bay—Herthas Flak, July 1927 and 1928. (The numbers of the plaice examined are given in brackets).

Depth zone	Year	I-Group			II-Group			III-Group		
		♂	♀	♂+♀	♂	♀	♂+♀	♂	♀	♂+♀
5—15 m.	1927	12.1 (61)	12.1 (53)	12.1	19.0 (404)	18.9 (508)	19.0	..	25.0 (1)	25.0
	1928	11.1 (265)	11.1 (301)	11.1	18.3 (170)	18.2 (237)	18.2	22.1 (93)	22.6 (105)	22.4
15—25 m.	1927	12.1 (65)	12.2 (55)	12.2	19.1 (448)	18.7 (569)	19.0	30.0 (2)	..	30.0
	1928	11.7 (93)	11.7 (83)	11.7	18.0 (148)	17.8 (123)	17.9	21.2 (31)	22.0 (31)	21.6
25—35 m.	1927	11.3 (12)	10.9 (11)	11.2	19.2 (147)	19.2 (140)	19.2	..	..	..
	1928	12.4 (13)	12.0 (7)	12.2	19.8 (13)	18.7 (22)	19.1	21.7 (7)	23.0 (7)	22.5
> 35 m.	1927	..	..	..	20.0 (4)	20.5 (2)	20.2	..	29.5 (2)	29.5
	1928	13.7 (3)	..	13.7	19.8 (6)	17.8 (6)	18.8	26.1 (8)	23.5 (6)	25.0

In Table 25 the July fishing experiments in 1927 and 1928 are taken separately and we see that the average length of the plaice of any given age-group in each depth

[1]) C. G. Joh. Petersen: On the stock of plaice in relation to the intensive fishing of the present time in the Belt Sea and other waters. Report of the Danish Biological Station. XXVII. 1921.

zone was less in 1928 than in 1927 in every case where the number of plaice examined was large enough to permit of the average length being determined with sufficient accuracy. The average catches per 30 minutes' haul of all the plaice are also entered in the Table. We see that the difference in average length for the two years seems to follow the same rule as in the Horns Reef area, viz. that the average lengths, undoubtedly on account of the competition for food, vary from year to year inversely with the total density of the plaice in the area[1]). The apparent difference in growth in September 1929 and in July 1927 and 1928, for which the migrations of the plaice afford a natural explanation, is discussed on p. 33.

In the Table below will be found a comparison between the average lengths of the separate age-groups in 1905—1907, determined by A. C. JOHANSEN from the results of fishing experiments in the area Aalbæk Bay—Herthas Flak, and the average lengths in 1927—1929.

Table 26. Average lengths of the age-groups 0—III in the area Aalbæk Bay—Herthas Flak.

	1905—1907[2]) 6—24 m. Sept.—March	1927—1929 5—35 m. July	Sept.
0-Gr.	8.4 cm.	?	?
I-Gr.	16.7 -	11.4 cm.	13.8 cm.
II-Gr.	23.5 -	18.8 -	22.2 -
III-Gr.	28.7 -	22.2 -	26.5 -

The mean length of any given age-group at the same time of year was thus c. 1—3 cm. less in 1927—1929 than in 1905—1907. This difference is so slight, considering the differences in length of the same age-group which can occur from year to year, that we cannot deduce therefrom that there is any difference between the growth conditions of the present day and of former years. As regards the Horns Reef area, A. C. JOHANSEN has shown from the results of marking experiments in the years 1902—1906 that the growth in the course of a year varied on an average from 4 to 7.7 cm.[3]).

The differences which may occur from year to year in the growth of the plaice do not however seem, according to the investigations undertaken, to be so great in the area Aalbæk Bay—Herthas Flak as in the Horns Reef area.

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[1]) A. C. JOHANSEN: Contribution to the biology of the plaice III. Medd. f. Komm. f. Havunders. Ser. Fiskeri. Bd. III, No. 4, 1908, p. 37 and AAGE J. C. JENSEN: An Investigation of the stock of plaice in the southern Horns Reef Area in the years 1925 and 1927. Medd. f. Komm. f. Havunders. Ser. Fiskeri. Bd. VIII, No. 6, 1928, p. 42.

[2]) A. C. JOHANSEN: Bericht über die dänischen Untersuchungen über die Schollenfischerei etc. Medd. f. Komm. f. Havunders. Ser. Fiskeri. Bd. III, No. 8, 1910, p. 84. — A small number of plaice from the area immediately to the north of Læsø are included in this calculation of the mean figures.

[3]) A. C. JOHANSEN: loc. cit. 1910, p. 76.

2. Comparison between the Average Lengths of the Age-groups in the Period 1927—1929 and in former Years in the middle and southern Kattegat.

In the middle and southern Kattegat a comparison between the average lengths of the age-groups in the period 1927—1929 and in former years is possible both for that part of the Shallows in the western Kattegat that lies to the west of the line from the western point of Læso to Fornæs where the depth is 5—22 metres and for the deep south-eastern part of the Kattegat and the Sound.

a) The Shallows in the western Kattegat, to the west of the line from the western point of Læsø to Fornæs.

In the Table below will be found a comparison between the lengths of the age-groups I, II, and III in that part of the Shallows in the western Kattegat that lies to the west of the line from the western point of Læsø to Fornæs where the depth is 5—22 metres.

The fishing experiments from 1905—1907 were carried out from the "Thor" with a 50 foot otter trawl. As this implement only rejected plaice smaller than 13 cm. the average lengths found at the fishing experiments from 1905—1907 are comparable, to an adequate degree, with the average lengths found at the fishing experiments carried out from the "Japetus Steenstrup" with fine-meshed otter seine, and particularly as regards the II- and III-Groups.

Table 27. Average lengths of the age-groups I—III in the middle and southern Kattegat, W. of the line from the western point of Læsø to Fornæs. Depth 5—25 metres, 1905—1907 and 1927—1929.

	1905—1907	1927—1929	
	Sept.—March	May—July	Aug.—Sept.
I-Gr.	18.3 (417)	13.1 (92)	15.7 (156)
II-Gr.	24.4 (101)	22.6 (277)	22.7 (22)
III-Gr.	25.3 (24)	26.1 (32)	

It will be seen that, as in the area Aalbæk Bay—Herthas Flak, no material difference in the average lengths of the age-groups for the two periods can be shown to exist in this area.

b) The Sound and the south-eastern Kattegat.

As has been shown on p. 21 and 28, the plaice stocks in the Sound and the deeper parts of the south-eastern Kattegat respectively as regards age composition and the mean lengths of the age-groups are so alike that without committing any serious error we can treat them as one. From the south-eastern Kattegat and Sound we possess measurements of a large number of plaice caught partly in 1905, partly in 1922, and partly in 1930. The measurements from 1921—1922 and 1930 are of plaice caught in commercial fishing operations; for the year 1922 the lengths of the III- and IV-Groups alone are recorded, since the plaice under 25 cm. were able to escape from the fishing implements or were rejected by the fishermen before landing. For the same reason the length calculated for the III-Group in June 1922 is undoubtedly too great.

Table 28. Comparison between the average lengths of the different age-groups in 1905—1907, 1922, and 1930 in the deeper parts of the south-eastern Kattegat and Sound. (The numbers of plaice examined are given in brackets).

		1905—1907 Sept.—March 17—37 m. Fishing experiments with otter seine	1922 June 17—18 m. Commercial catches	1930 Febr. 12—20 m. Commercial catches
I-Gr.	♂	19.6 (63)		
	♀	22.5 (11)		
II-Gr.	♂	24.2 (33)		29.9 (19)
	♀	26.3 (38)		30.3 (44)
III-Gr.	♂	25.6 (42)	27.1 (10)	31.7 (3)
	♀	27.8 (56)	27.7 (26)	32.6 (5)
IV-Gr.	♂	24.2 (6)	28.4 (11)	29.5 (2)
	♀	30.5 (13)	28.3 (46)	40.4 (5)
V-Gr.	♂	34.0 (3)		
	♀	33.6 (5)		

When we consider that the plaice examined in 1922 were caught in June, i. e. prior to the greater part of the growth period, it is clear that the mean lengths of the age-groups III and IV in 1922 were larger by a few centimetres than in 1905, and that the mean lengths in 1930 were again somewhat higher, and so much that the length of the II-Group was then greater than that of the IV-Group in 1905—1907.

3. Comparison between the Average Lengths of the Age-groups in the Period 1927—1929 and in former Years in the Belts.

In the Table below the average lengths of the different age-groups, as found at the fishing experiments in the years 1927—29, are compared with the average lengths found before the intensive fishery started.[1])

Table 29. The average lengths of the I-, II- and III-Groups of plaice in September—March in the northern Belt Sea and Great Belt outside the 15 metre line in 1907—11 and 1927—29.

	1907—1911[2])	1927—1929
I-Gr.	c. 16 cms.	c. 18 cms.
II-Gr.	c. 20 -	c. 25.5 -
III-Gr.	c. 23 -	c. 30 -

It will be noticed that the average lengths of the age-groups have increased here, and particularly in the case of the II- and III-Groups.

[1]) cp. C. G. Joh. Petersen: 1921 loc. cit.

[2]) A. C. Johansen: loc. cit. 1912, p. 31 and Tables 3—9 and 14.

4. Causes of the Increase in the Average Lengths of the Age-groups in the south-eastern and southern Kattegat, and in the Sound.

It is clear from the comparison between the average lengths of the age-groups in 1927—29 and in former years that neither in the area Aalbæk Bay—Herthas Flak nor in the Shallows in the western Kattegat to the west of the line from the western point of Læsø to Fornæs can any increase be shown to have occurred in the lengths of the different age-groups. In the deep south-eastern Kattegat and in the Sound, however, it could be established that such an increase had taken place. In the latter area the increase in the average lengths of the age-groups was about the same as in the Belts, the average lengths of the different age-groups being still somewhat higher than in the Belts.

That no increase in the average lengths of the different age-groups could be found in the northern and western parts of the Kattegat fully agrees with the fact that, as A. C. Johansen has shown, the fishery in the Kattegat had already before 1900 reached such an intensity that the total yield of the fishery culminated (the third stage).[1]) This stage signifies that the stock has been so thinned out that the accumulated stock has been for the most part captured and the density has been so reduced that the growth rate is no longer accelerated to any appreciable extent by further thinning out.

That the average lengths of the plaice of the different age-groups have increased so greatly in the deep south-eastern Kattegat and in the Sound must without doubt be ascribed to the facts firstly that the stock in this area has reached the above-mentioned third stage later than the stock in the western and northern Kattegat, secondly that the numerical proportion between these two races of plaice in the stock has now changed with the result that the North Sea race now constitutes a larger proportion, and thirdly that the Baltic plaice which emigrate from the Belt Sea and the adjacent parts of the Baltic into the Kattegat now have a greater average length for each age-group. The racial investigations carried out in large numbers by A. C. Johansen showed that the stock in the middle and southern Kattegat consists of a mixture of the two races, the large plaice of the different age-groups belonging mainly to the North Sea race and the small ones to the Baltic race.[2]) Owing to the plaice stock in the Belt Sea and the adjacent parts of the Baltic having been so greatly reduced, the emigration of the Baltic plaice into the Sound and the middle and southern Kattegat has necessarily decreased.

The stock in these regions is thus now, to a greater extent than before, dependent on recruits from the nursery grounds of the middle and western Kattegat.

Protection of these nursery grounds against injurious fishing has therefore now become a question of very great importance for the plaice fishery which is carried on in the Kattegat.

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[1]) A. C. Johansen: On a proposed close Season for the Plaice Fishery in the Belt Sea and the Baltic. Cons. Perm. Internat. Rapports et Procès-Verbaux. Vol. XLVIII. 1928.

[2]) A. C. Johansen; 1910. loc. cit. p. 122 et seq.

V. The relative Frequencies of the different Year-classes.

As we know from the investigations which have been carried out since 1901 by A. C. Johansen, there is a considerable difference from year to year in the amount of plaice fry which is produced in the Kattegat and Belt Sea. The fishing experiments dealt with in the present paper afford a material with respect to certain areas which enables us to estimate the relative frequencies of the adult plaice of the different year-classes. Such an estimate is rendered difficult in the case of the Kattegat and Belt Sea by the fact that the stock outside the 5 metre line consists mainly of age-groups I, II, and III, whilst the older age-groups are represented very sparsely in the catches at the fishing experiments. From the fishing experiments of any one year we can therefore only deduce the relative frequencies of the year-classes for very few years prior to the year in question, whereas in an area such as the Horns Reef area we are in possession of a material from each year which covers about 5 age-groups. In the following we shall discuss one by one the different areas investigated in the Kattegat and the Belts.

It should be observed, in comparing the fishing experiments in the different years, that the age distributions found at the fishing experiments at the different times of year, e. g. in July and September, are not directly comparable, since the distributions of the different age-groups vary for the different times of year.

a) The area Aalbæk Bay—Herthas Flak.

The average numbers of plaice of age-group I and older which were caught per 30 minutes haul at the fishing experiments are shown in Table 30, and Fig. 9 shows graphically the age distribution.

Table 30. Average catches per 30 minutes' haul in the different depth zones in the area Aalbæk Bay—Herthas Flak. (The respective year-classes are given in brackets).

Depth zone	Month and Year	Number of stations	I-Group	II-Group	III-Group	IV-Group	V-Group
5—15 m.	July 1927	7	17 (1926)	144 (1925)	0.1 (1924)	(1923)	..
	July 1928	8	78 (1927)	61 (1926)	31 (1925)	3 (1924)	..
	Aug.-Sept. 1929	4	96 (1928)	31 (1927)	(1926)	(1925)	..
15—25 m.	July 1927	6	4 (1926)	48 (1925)	0.3 (1924)	..	..
	July 1928	6	22 (1927)	45 (1926)	10 (1925)	..	..
	Aug.-Sept. 1929	9	17 (1928)	13 (1927)	1 (1926)	..	..
25—35 m.	July 1927	4	(1926)	9 (1925)	(1924)	(1923)	..
	July 1928	6	3 (1927)	6 (1926)	2 (1925)	0.3 (1924)	..
	Aug.-Sept. 1929	9	0.7 (1928)	2 (1927)	0.3 (1926)	0.1 (1925)	..
> 35 m.	July 1927	5	(1926)	0.6 (1925)	0.4 (1924)	0.2 (1923)	0.2 (1922)
	July 1928	4	0.5 (1927)	2 (1926)	3 (1925)	(1924)	(1923)

It will be noticed at once that the stock in the area under consideration is composed for the most part of 2—3 year-classes. Even a year-class such as 1925, which as II-Group was abundantly represented in July 1927, was in the following July as III-Group only present in numbers which constituted a fifth of its former numerical strength. This

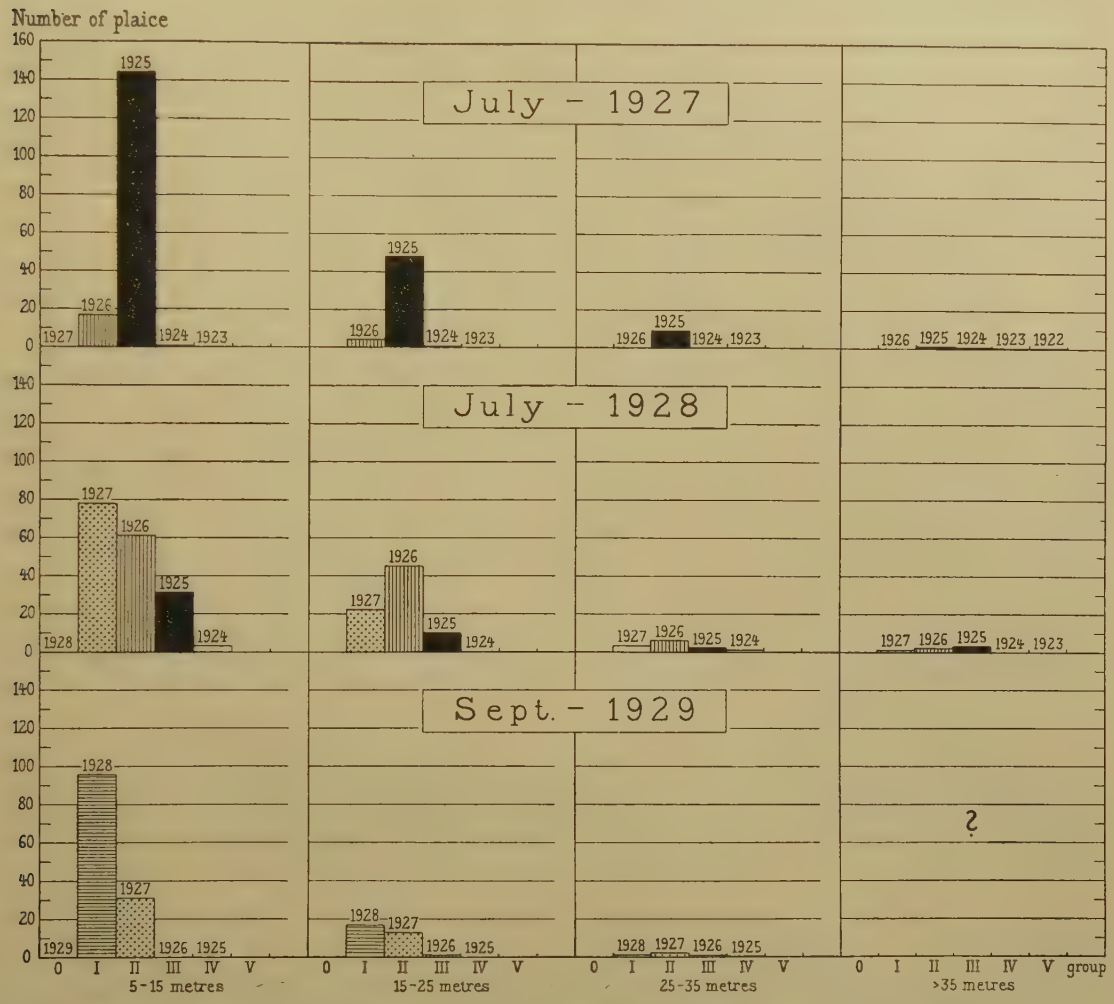

Fig. 9. Average catch per 30 minutes haul with fine-meshed otter seine of the different age-groups in the various depth zones of the Aalbæk Bay—Herthas Flak area in July 1927, July 1928, and September 1929.

decrease in density from the II-Group to III-Group was uniform in all depth zones out to 35 metres; the relation between the numbers of the II-Group in 1927 and the numbers of the III-Group in 1928 was 0.21, 0.21, and 0.22 in the depth zones 5—15 m., 15—25 m., and 25—35 m. respectively. This figure for the decrease in density does not of course correspond to the decrease in number of the plaice of this year-class which took place

in the course of a year, but is partially due to the facts that the main distribution of the III-Group is found in rather greater depths than that of the II-Group, and that the size of the depth zones increases with the depth.

If we compare the July fishing experiments in 1927 and 1928 we see that, as regards the relation between the numbers of the I-Group in the two years, the 1927 year-class was represented much more abundantly than the 1926 year class. As regards the numbers of the II-Group in the two years, we see that in the depth zone 5—15 m. it was $2^1/_2$ times more abundantly represented in 1927 than in 1928 whilst in the other depth zones the numbers were very nearly equal for the two years. It thus seems that the 1925 year-class was a little more abundant than the 1926 year-class. The relation between the numbers of the III-Group in 1927 and 1928 proves without doubt that the 1925 year-class was considerably more abundant than the 1924 year-class.

If we now compare the fishing experiments in July 1927 and 1928 with those in September 1929 we see that, as regards the II-Group, the year-classes 1925 and 1926 were apparently more abundant than the 1927 year-class. A natural explanation for this is, however, afforded by the fact that between July and September the II-Group was emigrating into deeper water and was therefore dispersed over larger areas, becoming correspondingly less dense. In the same way, as regards the III-Group, the numerical superiority of the 1925 year-class at the 1928 fishing experiments over the 1926 year-class at the 1929 fishing experiments was greater than it was found to be when comparing the 1927 and 1928 fishing experiments. Also the I-Group was emigrating from the coastal zone between July and September and we cannot therefore draw any completely accurate conclusion from its numbers in July 1927 and 1928 and in September 1929 as to the relation between the numbers of the 1928 year-class and those of the 1926 and 1927 year-classes. It seems as if the 1928 year-class was not more abundant than the 1927 year-class, but was possibly somewhat poorer.

It will thus be seen that the three years experiments show that in the area Aalbæk Bay—Herthas Flak the 1927 year-class was the most abundant and the 1924 year-class weakest, the 1925 and 1926 year-classes being intermediate. Of these latter the 1925 year-class was somewhat more abundant than the 1926 years-class.

b) The middle and southern Kattegat.

The numbers of plaice of the different age-groups caught per unit of time are shown in the Table below.

In all the areas considered here within the middle and southern Kattegat the II-Group was predominant at the 1927 fishing experiments, i. e. the 1925 years-class. On the other hand at the 1928 fishing experiments the I-Group, i. e. the 1927 year-class, was predominant in all the areas with which the investigations in that year were concerned; the 1925 year-class, however, was found in fairly large numbers in the area along the coast of Jutland at depths of 5—10 metres. Finally at the 1929 fishing experiments the I-Group, i. e. the 1928 year-class, was predominant in the Shallows of the western Kattegat.

Table 31. Mean numbers of plaice of the various age-groups caught per 30 minutes' haul with the otter seine in the middle and southern Kattegat in the different months 1927, 1928, and 1929. Year-class is shown in brackets.

		Date and Year	Total duration of hauls minutes	I-Group	II-Group	III-Group	IV-Group
The Shallows in the western Kattegat	Along the coast of Jutland, 5—10 m.	4-8/5 1927	185	0.0 (1926)	22 (1925)	0.5 (1924)	..
		6-7/7 1927	98	0.9 (1926)	26 (1925)	0.0 (1924)	..
		23/6-7/7 1928	150	16 (1927)	0.8 (1926)	6 (1925)	..
		8/8-14/9 1929	195	17 (1928)	3 (1927)	0.1 (1926)	..
	W. of West-point of Læsø—Fornæs, 10—22 m.	4-6/5 1927	195	..	6 (1925)	..	..
		7/7 1927	60	..	5 (1925)	..	..
		7/6 1928	110	1 (1927)	0.3 (1926)	..	..
		9/8 1929	60	24 (1928)	..	..	..
	E. of Læsø—Fornæs, 10—20 m.	27/5 1927	150	..	0.4 (1925)	..	..
		6-14/8 1929	180	0.3 (1928)	..	..	..
Deeper parts of the Kattegat > 20 m[1])		20-28/5 1927	351	..	0.2 (1925)	0.1 (1924)	0.2 (1923)
The Shallows along the coast of Sealand 5—20 m.		20/5 1927	90	0.3 (1926)	1 (1925)	..	..
		4/8 1928	60	1 (1927)	..	..	..
		31/7-4/8 1929	55	..	0.5 (1927)	..	..

[1]) Including 1 station S.E. of Hastens Grund, at 19 metres depth.

As III-Group, only the 1925 year-class was found in quantities of any importance. As II-Group, the 1925 year-class was most abundant, the 1927 year-class being the next most abundant, while the 1926 year-class was the most scanty. As I-Group, about which we can only judge with any accuracy from the numbers along the coast of Jutland in the 5—10 metre zone, the 1927 and 1928 year-classes were the most abundant and the 1926 year-class the most scanty.

It will thus be seen that the 1925 year-class in the middle Kattegat was the most abundant while the 1927 and 1928 year-classes were also comparatively well represented. The 1926 year-class was poor.

c) The Belts.

The numbers of plaice of the different age-groups caught per 30 minutes' haul in the northern Belt Sea, Great Belt, and the Smaalandshavet are given in the Table below.

The plaice of the different age-groups caught per 30 minutes' haul are thus few in number. Owing to the fact, however, that the fishing experiments were fairly comprehensive in several cases, (cp. Charts, Fig. 1), and that the difference between the numbers

Table 32. Average numbers of plaice of the different age-groups caught per 30 minutes' haul with the tog in the northern Belt Sea, Great Belt, and the Smaalandshavet in the different months of 1927, 1928, and 1929.

Month	Date and year	Total duration of hauls minutes	I-Group			II-Group			III-Group		
			♂	♀	♂+♀	♂	♀	♂+♀	♂	♀	♂+♀
May-June	$^{9}/_{5}$-$^{18}/_{6}$ 1927	979	0.2	0.1	0.3	5	4	9	0.2	0.1	0.3
	$^{14}/_{5}$-$^{19}/_{4}$ 1928	925	0.1	0.1	0.2	0.0	..	0.0	0.3	0.3	0.5
July-Aug.	$^{11}/_{7}$-$^{12}/_{8}$ 1928	700	0.2	0.3	0.5	0.1	..	0.1	0.2	0.2	0.3
	$^{7}/_{7}$-$^{23}/_{7}$ 1929	345	1	1	2	0.3	1	1	..	..	..
Sept.-Oct.	$^{27}/_{9}$-$^{5}/_{10}$ 1928	190	0.2	..	0.2	0.9	0.3	1	..	0.2	0.2

of the different age-groups proved to be very great, we may ascribe some importance to the results of the fishing experiments as an index of the relation between the numbers of plaice in the different age-groups.

This is confirmed by taking separately (see below) the northern Belt Sea and Great Belt.

As the horizontal extent of these areas is so great and as they differ fairly considerably both in situation and in respect of the hydrographic conditions, we cannot from the outset be certain that it is the same year-classes which are predominant for instance in the northern and the southern part. We will therefore consider the age distribution of the plaice in each of the two areas, i. e. the northern Belt Sea and Great Belt. In thus taking the two areas separately the year 1929 is represented by too few plaice so that it is not worth while including the experiments for this year.

In the Table are included only the series of fishing experiments in which the aggregate duration of the hauls with fine-meshed otter trawl in the waters in question exceeded

Table 33. The percentages of plaice of the different age-groups caught per 30 minutes' haul with the tog in the northern Belt Sea, Great Belt, and Smaalandshavet in the different months of 1927 and 1928.

Area	Month	Date and year	Total duration of hauls minutes	I-Gr.	II-Gr.	III-Gr.	IV-Gr.	V-Gr.
Northern Belt Sea	May-June	$^{9}/_{5}$-$^{17}/_{6}$ 1927	505	5	89	4	2	..
		$^{18}/_{5}$-$^{22}/_{5}$ 1928	505	7	7	86	..	..
	July-Aug.	$^{31}/_{7}$-$^{5}/_{8}$ 1928	315	33	22	33	11	..
Great Belt	May-June	$^{30}/_{5}$-$^{18}/_{6}$ 1927	335	1	89	1	3	..
	July-Aug.	$^{28}/_{7}$-$^{5}/_{8}$ 1928	260	23	8	31	8	8

4 hours. It will be seen that the northern Belt Sea and Great Belt present approximately the same variations as regards the relative frequencies of the years-classes.

It must be remembered that the figures given in Table 33 are percentages, and that we therefore cannot by means of them directly draw conclusions from the frequency of a given age-group in two years as to the relation between the frequencies of the two year-classes which the age-group represents.

It will be seen from Tables 32 and 33 that the 1925 year-class as II-Group in 1927 was far more abundantly represented in the catches than was the 1926 year-class as II-Group in 1928, since in 1927 9 plaice of the 1925 year-class were caught on an average per 30 minutes' haul whilst in 1928 less than 0.05 plaice of the 1926 year-class were caught per 30 minutes' haul; in both series of fishing experiments the aggregate duration of hauls was 15—16 hours.

This numerical relation between the frequencies of the 1925 and 1926 year-classes is confirmed by the numerical relation found at the July—August fishing experiments between the III-Groups in 1928 and 1929.

From the numerical relation between the II-Groups in 1928 and 1929 found at the July—August fishing experiments we can deduce that the 1927 year-class was more abundant than the 1926 year class but not to so great an extent as was the 1925 year class. This same relation between the frequencies of the three year-classes was found to hold good in the western part of the middle and southern Kattegat.

In the age analyses of plaice from Kerteminde Bay we possess further material for the investigation of the relative frequencies of the different year-classes.

Table 34. The numbers of plaice of the different age-groups in samples of plaice from Kerteminde Bay, March 29th, 1928. Depth 4—5 metres.

0-Group	I-Group			II-Group			III-Group			?	
♂+♀	♂	♀	♂+♀	♂	♀	♂+♀	♂	♀	♂+♀	♂	♀
5	19	26	45	175	226	401	11	16	27	1	1

This marked predominance of plaice of the II-Group over those of the other age-groups show that the 1925 year-class was much more abundant than the 1926 and 1924 year-classes.

Moreover, different samples of plaice caught at commercial fishing operations in the Belts have been analysed. The age composition of the plaice is shown in Table 35 below, both for all the plaice in the samples and for the plaice which have been determined as Belt Sea plaice by Dr. A. C. Johansen from the appearance of their otoliths (growth conditions).

The 1927 year-class as II-Group is very conspicuous for its high percentage in these samples, despite the fact that many plaice in this age-group were able to escape from the meshes of the implements.

Table 35. The percentages of commercial plaice in the different age-groups among the Belt Sea plaice, 1929—30.

Age-group		I	II	III	IV	V	VI	VII +
Year-class		1928	1927	1926	1925	1924	1923	1922
W. of Samsø	All plaice	4	58	10	23	3		1
7. Jan. 1930	Belt Sea plaice	5	71	11	11			1
N.E. of Romsø	All plaice		47	18	29	2	2	2
6. Jan. 1930	Belt Sea plaice		61	20	12	1	3	3

It is particularly noteworthy that the 1925 year-class (IV-Group), both in the sample from the waters to the west of Samsø and in the sample from near Romsø, was found in larger numbers in the aggregate catch than the 1926 year-class (III-Group), but among the plaice determined as belonging to the Baltic race it was found to be no more numerous than the 1926 year-class. In the Horns Reef area the 1925 year-class was found to be very numerous,[1]) and the transplantation of plaice from the North Sea in 1928 and 1929 has thus been one of the causes of this year-class being so abundantly represented. That the 1925 year-class, however, apart from this was one of the most abundant in the Belts is clear from Table 35 as also from a consideration of the frequencies of the age-groups in 1927.

In all the areas investigated the 1925 and 1927 year-classes were found to be more abundant than the 1924 and 1926 year-classes.

Greater variations from year to year in the frequencies of the separate age-groups were found on an average to occur in the Belts than in the area Aalbæk Bay—Herthas Flak. It was moreover apparent that, as regards the areas outside the 5 m. line, even an abundant year-class in the area Aalbæk Bay—Herthas Flak could only predominate over the poorer year-classes on either side of it for one year, since emigration from year to year is very great. In the other areas it was possible for an abundant year-class to predominate over the poorer year-classes on either side of it for two or three consecutive years partly on account of the great difference between the frequencies of the year-classes.

In the northern Kattegat there have been variations from year to year in the frequencies of the year classes equal to those shown to occur in the south-easterly North Sea.[2])

When the variations between the frequencies of the year-classes are no greater than in the area Aalbæk Bay—Herthas Flak and the growth rate alters only slightly from year to year the distribution of the plaice stock becomes fairly uniform from year to year, a fact which facilitates the delimitation of a definite protected area.

VI. Summary.

The numerical distribution of the plaice in the different areas. In the areas of the Kattegat which have been investigated there is a very great difference between the density in the nursery grounds of the area Aalbæk Bay—Herthas Flak and in the Shallows of the western Kattegat to the west of the line from the west point of Læsø to Fornæs on the one hand and the density of the remaining areas on the other. Especially in the deeper eastern and south-eastern parts of the Kattegat there is a very

[1]) Aage J. C. Jensen: 1928. loc. cit.

[2]) cp. Table 30 with Tables 20 (p. 24) and 21 (p. 26) in Aage J. C. Jensen 1928. loc. cit.

scattered stock, as is shown by the quantitative fishing experiments. This numerical distribution is illustrated by Charts, Figs. 1—5 and Tables 1—8. They show that, whilst the number of plaice caught per 30 minutes' haul with otter seine from the "Japetus Steenstrup" in the area Aalbæk Bay-Herthas Flak in depths up to 15 metres exceeds 100 and does not sink lower than about 10 until a depth of 30 metres is reached and whilst in the Shallows of the western Kattegat to the west of the line from the west point of Læsø to Fornæs there is a similar density of over 10 plaice per 30 minutes' haul, the density in the rest of the Shallows and in the deeper parts of the eastern and southern Kattegat and in the Sound is represented by under 0.5 plaice per 30 minutes' haul.

Whereas over 90 % of the plaice in the above-mentioned nursery grounds are less than 26 cm. in length, the plaice exceeding 26 cm. in length predominate in the deeper areas, i. e. the commercial plaice areas, so that practically all the plaice caught at the fishing experiments in the south-eastern and southern Kattegat outside the 20 metre line exceed this length. In the northern Kattegat the majority of the plaice in depths exceeding 35—40 metres are over 26 cm. in length (see Fig. 7).

Average Length of the Age-groups.

a) The nursery grounds. The average length of the plaice of the same age is greater in the area Aalbæk Bay—Herthas Flak than in other important nursery grounds for the North Sea race of plaice, viz. the Horns Reef area and Nissum Broad (see Tables 12 and 13), and in the western part of the Shallows of the western Kattegat it is still greater (Tables 15 and 16). The density of the plaice seems thus not to be too great in proportion to the amount of food available, but appears to admit of a growth which is rapid enough to enable the stock in those parts of the Kattegat where the commercial plaice predominate to be quickly recruited. The rapid emigration to adjacent districts is also apparent from the fact that it is chiefly the first three age-groups which constitute the stock in the nursery grounds. The majority of plaice exceed 25 cm. in length as III-Group (see Fig. 8, p. 33) and emigrate from the area.

It is of especial interest that the average lengths of the age-groups in these nursery grounds have not changed since the beginning of the present century to a sufficiently great extent for the change to be definitely established (Tables 26 and 27).

b) The commercial plaice areas. The average lengths of the different age-groups are considerably greater in the eastern and southern parts of the Kattegat and in the Sound than in the nursery grounds. The average lengths in these areas can be shown to have increased steadily since the beginning of the century and also in the last decade, so that the average length of the II-Group is now greater than was that of the IV-Group in 1905—07 (see Table 28). This increase in average length is chiefly due to the thinning out of the stock by the intensive fishery and took place concurrently with a juvenescence of the plaice caught in commercial fishing operations. By examining samples of plaice caught in commercial fishing operations in the Sound in 1921—22 outside the 15 metre line, 39 % of the stock was found to belong to the IV-Group or older groups but in 1930 only 10 %. The thinning out of the stock in the eastern and southern parts of the Kattegat and in the Sound may be ascribed partially to the fact that the number of plaice of the Baltic race which immigrate into this area from the Belt Sea

and the adjoining parts of the Baltic is now far smaller than formerly by reason of the marked thinning out of the stock in these areas caused by the intensive "overfishing", but is due chiefly to an "overfishing" of the stock also in the Kattegat. As has been shown in the paper by A. C. JOHANSEN: "On the decrease in the yield of the Plaice Fishery in the Kattegat and Skagerak in the last decennaries and causes of the same". (The present Report) the yield of the fishery in the Kattegat has decreased steadily since the beginning of the present century, which accords with the thinning out of the stock established by the fishery investigations.

The plaice stock in the central Kattegat is now mainly dependent on recruiting from the nursery grounds in the northern and western Kattegat.

The relative frequencies of the year-classes. It is interesting to note that on an average not such great differences between the frequencies of the year classes were found in the area Aalbæk Bay-Herthas Flak as in the southern areas of the Kattegat and especially in the Belts (Tables 30—35). For this reason a comparatively steady emigration of commercial plaice can take place from year to year from the nursery grounds in the northern and western Kattegat into the areas where the commercial plaice predominate.

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Investigations of Plaice off the West-Coast of Sweden.

By

Arvid R. Molander.

With an Introduction by K. A. Andersson.

Introduction.

In the following paper by Dr. A. R. Molander on the conditions of existence of the plaice on the west coast of Sweden and particularly in some of the larger fjords, it is shown that, as a rule, a considerable number of young plaice live in these fjords. As many as 400 to 500 fish have been taken in an hour, fishing with a small sized trawl-net. Plaice, however, do not spawn inside the skerries but, on the approach of maturity, go out of the fjords and then principally to the breeding grounds beyond the Swedish coast and in the neighbourhood of the Skaw. The stock in the fjords is recruited mainly by the immigration of quite young bottom-stages. Also in the Swedish territory outside the skerries there often occurs a good stock of young plaice. The spawning grounds off the Swedish coast are, however, rather small, for which reason most of the plaice that have grown up on the Swedish coast probably migrate, when approaching the age of maturity, over to the Danish coast and some even to the North Sea. Consequently the Swedish stock of plaice forms a part of the stock in the northern Cattegat—Skager Rack—North Sea. The Swedish skerries and the contiguous area thus constitute mostly transition areas for the plaice, from the earliest bottom stages to that approaching pubescence. The Swedish territorial waters ought therefore to play a considerable part in the maintenance of the stock of plaice in the Cattegat and Skager Rack.

The Swedish territory is reckoned to extend four geographical miles (minutes) out to sea from the outermost skerries. Since 1900 fishing with trawls has been prohibited in Swedish territory except shrimp fishing to some extent with very small trawls and since 1895 fishing with Danish seines has also been prohibited in the Swedish territory outside Göteborg and Bohus Len, except in the outer parts. Some years ago fishing with Danish seines was also prohibited in certain parts of the sea territory off Hallands Len southwards to Varberg. Consequently the stock of plaice on the Swedish coast is protected against great and intensive fishery.

The plaice fishery is, however, of minor importance in the Swedish territory. It

is carried on inside the skerries, almost exclusively for household use, with stationary nets. Plaice may besides, be caught accidentally in nets hauled towards the land, when fishing for mackerel, herring, or sprat.

Only in the outer parts of the sea territory outside Göteborg and Bohus Len, between the Haallö and Vinga Light-houses, is the plaice fishery carried on with Danish seines. In Hallands Len such fishery in Swedish territory can occur only in areas outside Kungsbacka and Halmstad and then only to a small extent.

The important protection of plaice which Sweden has thus endeavoured to yield ought to be completed by preservative measures in the international sea areas in the Cattegat and Skager Rack.

Stockholm, June 1930. K. A. Andersson.

The investigations on the plaice off the west-coast of Sweden have been mainly concentrated upon the coastal waters of Bohuslän and a number of its fjords. Not untill the summer of 1929 were the investigations extended to comprise also the coast of Halland, but only as far as the distribution of the youngest year-classes — the 0- and I-groups — were concerned. In the Bohuslän, on the other hand, the investigations for a number of years were focussed principally upon the stock of older plaice though only in a limited number of fjords, for the most part such in which the stock of plaice was fairly abundant and where there was the possibility of fishing by means of trawls. The following fjords were regularly investigated: Björkö Fjord, Stig Fjord, Ellös Fjord, Gullmar Fjord, Bro Fjord and Åby Fjord. More occasionally the outer waters of Hake Fjord and the waters of Marstrand Fjord, Askerö Fjord, Havsten Fjord and the Kalvö and Kolje Fjords were examined (cp. Chart I). Off the Swedish part of the Kattegat Coast fishing for plaice was, on the other hand, carried on mainly in the open waters; in the northern part, only, fishing took place also within the belt of rocks forming the so-called "Skärgård" (cp. Chart III).

1. The Topography and Bottom Fauna of the Bohuslän Fjords and the Food Conditions for the Plaice.

As regards the Bohuslän Fjords, which have been thoroughly investigated, we can take separately a group consisting of Åby Fjord and Bro Fjord and the Gullmar Fjords. Each one of these fjords forms a separate fjord-system without connection with any of the other fjords through the Skärgård. They are all situated in the granite districts of Bohuslän, and however much they may differ from one another in several respects, they all have in common high steep shores washed by deep waters, and no large areas of shallows. Gullmar Fjord is the type, with very deep waters and fully developed "threshold" at the mouth. The others lack this, and thus, from a geological point of view, can hardly be considered as true fjords.

The Ellös and Stig Fjords represent quite a different type of fjord. Each of

these forms part of the fjord-system which borders the large isles of Orust and Tjörn, as is also the case with Askerö, Havsten, Kalvö and Kolje Fjords and the Hake Fjord. Ellös Fjord constitutes that part of the fjord-system on the north-west side which lies nearest to the sea, whilst Stig Fjord, also separating the Isle of Orust from the Isle of Tjörn washes the shores of the Orust farthest to the south and south-west. The first mentioned fjords thus do not form a delimited water area, except only for the outer somewhat broader parts of a series of waters which, with a common name are usually called the Udevalla Fjords, though they have in reality more the character of narrow sounds. The Ellös and Stig Fjords are fairly broad, shallow creeks, with many small isles and rocks. Off their shores shallows frequently occur, being, in Stig Fjord of considerable extent.

With regard to Björkö Fjord, which is situated directly north of Gothenburg, we have only to observe that in reality it consists of a narrow sound between the large Isle of Hissingen and one of the numerous isles forming the Gothenburg Skärgård. This sound is directly connected with the sea by a deep channel in the southern direction beyond the Vinga Light-house, whilst on the north side the fjord joins more shallow waters.

Gullmar Fjord which, throughout large areas, has a depth of about 100 to 125 metres, and, on the threshold about 40 metres, stretches about 22 kilometres into the interior of the land, forking off in its inner part into two branches, the Färlef Fjord and Saltkälle Fjord, the former being very shallow in its inner waters while the latter forms a more direct continuation of the deep channel of the main fjord. Gullmar Fjord has, even in its deep parts, a very rich and varied fauna, presenting moreover a number of well developed association types (cp. Molander 1928). With regard to the distribution of the plaice it should be observed that the large depth in the middle part of the fjord prevents a uniform distribution of this fish over the entire fjord, for which reason it is found only in the inner areas and at the mouth of the fjord (the threshold). On the threshold the plaice occur between the depths of 30 to 40 metres and also in towards the shallow sandy creeks in which, as opposed to elsewhere, a fairly good stock of the very youngest year-groups is found.

The plaice live mostly on clay or mixed clay and sand bottom among the communities of bottom organisms designated in my investigations of 1928 as *Brissopsis-Chiajei*, *Echinocardium-filiformis* (Petersen 1918), and the *Nephthys-nitida* associations; and, as far as concerns the younger broods, among *Nephthys-nitida*, *Scoloplos-cordatum* (Molander 1928), or the *Macoma* communities (Petersen 1918).

An investigation of the stomach contents of plaice (Table 1) from Gullmar Fjord shows that they seek their food preferably among those groups of animal organisms which can be included in the named associations, as for instance the species of *Amphiura*. The plaice are found, besides in the waters at the mouth, mainly in the inner parts of the Fjord, in Färlef Fjord and the broad district outside the mouth of Färlef Fjord which goes under the name of "the Broad". In these parts the larger plaice are found down to about 35 metres' depth, and also in shallower waters of Färlef Fjord among the communities of *Brissopsis-Chiajei* and *Echinocardium-filiformis*, whilst the youngest individuals — although in relatively scanty numbers as compared with the

Sennäs
Vädenbåd
Bottna Fjord
Färle Fjord
Saltkällefjord
Åby Fjord
Brofjord
Gullmar Fjord
Hufsfjord
Halvö Fjord
Tjälingarna
Gåven
Kalvö
Kalvöfjord
Kalvöfjord
Kalvöfjord

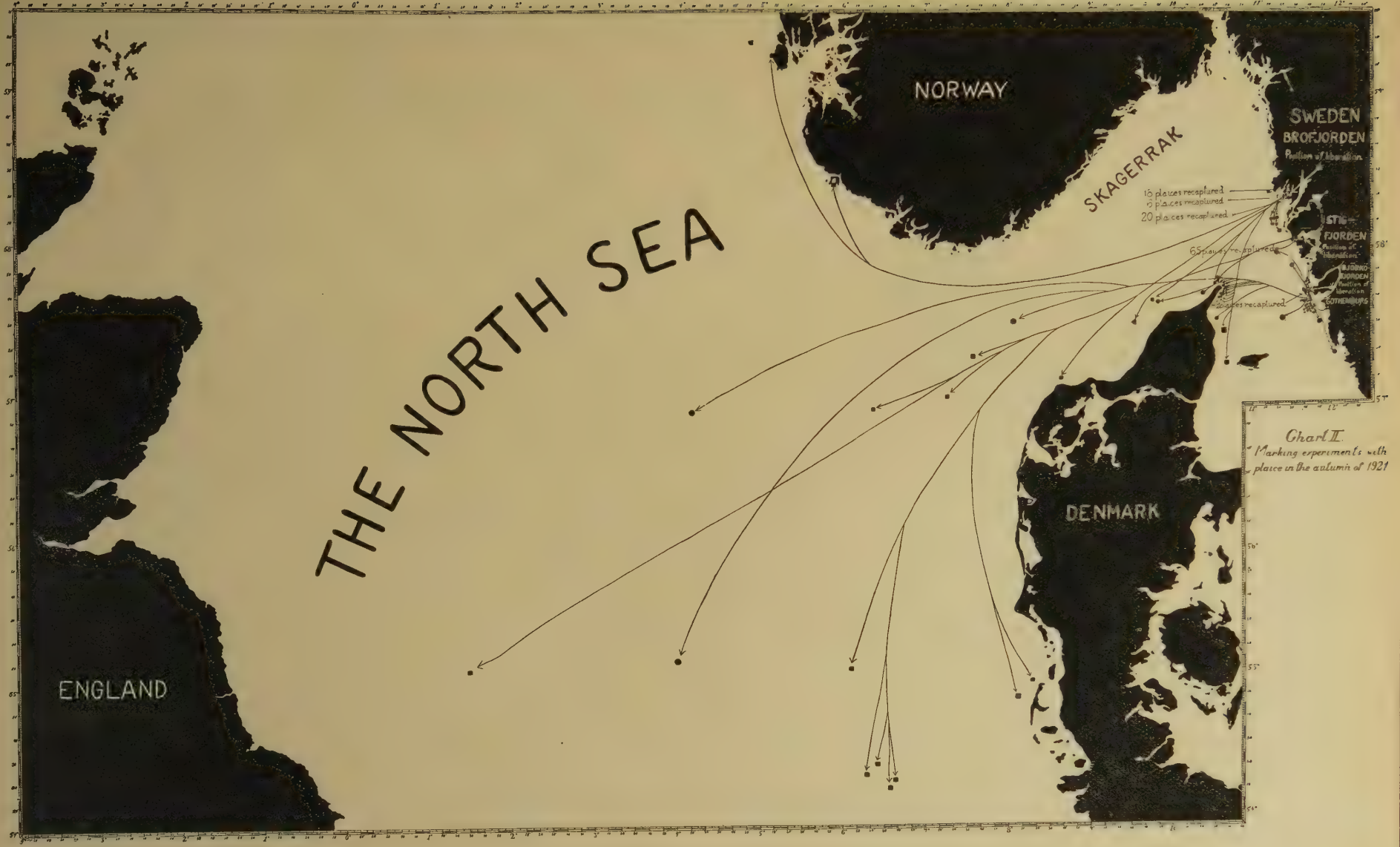

Chart II.
Marking experiments with plaice in the autumn of 1921

Chart III. Number of Plaice of 0- and I-group per haul with seine net of less than 30 minutes along the Swedish West Coast in August 1929. The first figures denote the number of plaice of the 0-group, the second the number of the I-group.

abundance in the outer districts — make their way into shallower parts of Gullmar Fjord, where the numerous varieties of the *Macoma* communities abound (cp. Table 1).

As regards topography Bro Fjord differs from Gullmar Fjord in being considerably more shallow, having only at the mouth a depth of somewhat above 40 metres. In its two inner branches the depth is usually not even 20 metres. In respect to fauna, Bro Fjord shows great resemblance to the inner shallower waters of Gullmar Fjord, and the communities of *Brissopsis-Chiajei*, *Echinocardium-filiformis*, and *Nephthys-nitida*

Table 1. Stomach Contents in Plaice from Gullmar Fjord.

Locality	Date	Depth in metres, Bottom conditions	Length in cm.	Sex	Stomach contents
The Threshold	$^{14}/_{6}$ 1923	5—9 m. sand	23	♀ 1	Remnants of polychaetes.
—	—	—	24	♂ 1	Amphiura filiformis, remnants of shells.
—	—	—	25	♂ 1	— — — —
—	—	—	23	♂ 1	Remnants of shells.
—	—	—	24	♂ 1	Amphiura sp., Nucula nitida.
—	—	—	31	♂ 1	Amphiura filiformis, remnants of shells (Nucula nitida).
—	—	—	24	♀ 1	Portunus sp.
—	—	—	31	♂ 1	Amphiura filiformis + A. chiajei.
—	—	—	27	♀ 1	Corbula, Syndosmya nitida.
—	—	—	30	♀ 1	Algae.
—	—	—	27	♀ 1	Amphiura filiformis, Ophiura sp.
—	—	—	33	♀ 1	— —
—	—	—	28	♀ 1	Indeterminable.
—	—	—	21	♀ 1	Patella (small).
Middle part	$^{25}/_{6}$ 1923	8—9 m. Clay, sand, Zostera	21	..	Cardium remnants.
—	—	—	21	..	Arenicola? Cardium remnants, polychaetes.
—	—	—	17	..	Empty.
—	—	—	26	..	Remnants of shell and polychaetes.
—	—	—	22	..	Cardium shell, polychaetes remnants.
—	—	—	17	..	Rissoa shell. — —
—	—	—	18	..	Syndosmya. — —
—	—	—	19	..	— —
—	—	—	23	..	Mysis. — —
—	—	—	18	..	Crangon. — —
—	—	—	18	..	Empty.
—	—	—	25	..	Pectinaria and polychaetes remnants.
—	—	—	20	..	— —
—	—	—	20	..	Empty.
—	—	—	18	..	Polychaetes remnants.
—	—	—	12	..	Cardium edule, little expl.
—	—	—	25	..	Shell remnants.
—	—	—	26	..	Idothea.
—	—	—	25	..	Carcinus (small), Amphipod, Rissoa.

Table 1 (continued).

Locality	Date	Depth in metres, Bottom conditions	Length in cm.	Sex	Stomach contents
Färlef Fjord	$^{13}/_{6}$ 1923	20—30 m. Clay	32	♀ 1	Remnants of Holothuria, polychaetes, Funiculina.
—	—	—	32	♀ 1	Amphiura filiformis.
—	—	—	32	♀ 1	— — Sipunculides.
—	—	—	36	♀ 1	— — —
—	—	—	33	♀ 1	— — —
—	—	—	32	♀ 1	— —
—	—	—	34	♀ 2	— — Cucumaria.
—	—	—	34	♂ 1	— — —
—	—	—	38	♀ 2	Fish remnants.
—	—	—	29	♂ 1	Amphiura filiformis + A. chiajei.
—	$^{3}/_{7}$ 1923	—	41	♀ 2	— — —
—	—	—	33	♀ 1	— — shell remnants, polychaetes (Rhodine, etc.).
—	—	—	36	♂ 1	Eumenia crassa.
—	—	—	33	♀ 1	— — , Amphiura filiformis.
—	—	—	34	♀ 1	Remnants of shell and polychaetes.
—	—	—	32	♂ 1	— — — — —

Table 2. Stomach Contents in Plaice from Bro Fjord.

Date	Depth	Length in cm	Stomach contents
$^{16}/_{10}$ 1922	28—35 m.	35	Amphiura filiformis + A. Chiajei, Ophiura texturata, Aphrodite.
—	—	34	— — — —
—	—	34	— — — —
—	—	39	— — — —
—	—	34	— — — —
—	—	29	— — — —
—	—	33	— — — —
—	—	35	— — — —
—	—	35	— — — —
—	—	33	— — — —
—	—	38	— — — —
—	—	40	— — — —
—	—	37	— — — — and polychaetes.
—	—	41	— — — and Arenicola.
—	—	37	— — — and Aphrodite.

live at the mouth as well as in towards the shallower inner regions (Table 2), these organisms being, however, considerably intermixed and interbreeding. Whithin the areas inhabited by these associations the plaice occur in relatively uniform distribution, the larger individuals appearing mostly, however, in the waters at the mouth, where the

depth is about 30 to 35 metres, whilst the youngest fish abound in the shallower sandy creeks in the outer parts of the Fjord, where the *Nephthys-nitida* and *Macoma* communities have their largest distribution.

Åby Fjord, like Gullmar and Bro Fjords, stretches like a long narrow wedge — about 10 kilometres in length — into the granite district of Bohuslän in a direction almost S.W. to N.E. It is even shallower than the last-mentioned fjord, as it is only at the mouth that it reaches a depth of 20 metres or slightly more. Its bottom usually consists of loose clay containing in many places masses of dead zostera. The two associations, *Echinocardium-filiformis* and *Nephthys-nitida* are distributed, greatly intermixed, throughout the fjord, the distribution of the plaice coinciding largely with theirs. The youngest individuals live in the few sandy creeks, appearing however, mostly — as in Bro Fjord and Gullmar Fjord — in the outer regions of the fjord.

The waters of Ellös Fjord are thickly dotted with islets and rocks, the mean depth rarely exceeding 8 to 10 metres. Its shores are frequently gently sloping, fairly extensive shoals being found in the creeks or between the islets. In the loose clay bottom, abounding in dead zostera, frequently of an oozy substance, the *Abra* communities live, the *Nephthys-nitida* associations replacing them in parts where the bottom is firmer on account of its being mixed with sand. The distribution of these communities, mainly of the former, coincides with that of the plaice. Here as elsewhere, the younger broods of plaice live in the shallow creeks, where the bottom consists of sand.

To a still greater extent than is the case with the last-mentioned fjord, the shores of Stig Fjord are cut asunder, being densely dotted as it is with numerous islets and rocks. Towards the west two narrow sounds connect the fjord with the sea. Apart from some minor areas in the outer districts; which have a depth of up to 25 metres, the fjord bottom is constituted largely of a shallow bank, with a channel of a depth ranging between 10 and 16 metres running through the middle part, whilst the mean depth is otherwise 7 to 9 metres, with rather extensive shoals inshore of 1 to 3 metres' depth. The plaice, which usually abound in this fjord, occur mostly in the middle and inner shallow areas, where the bottom consists chiefly of loose oozy clay, frequently covered with masses of dead zostera, and where the *Abra* community predominates, though they are also found in the deeper parts of the outer waters at the mouth, where the same community is also well developed. In the parts of the fjord where the clay bottom is of a firmer consistency, on account of its being more mixed with sand, and where the *Nephthys-nitida* communities frequently attain to a typical and fine development, the distribution of the plaice is, however, less regular. As it contains very highly developed *Abra* communities the Stig Fjord apparently offers the very best conditions for the plaice. The samples of stomach contents of the plaice in Stig Fjord tend to illustrate the importance of *Syndosmya alba* (*Abra*) as a nutritive factor (Table 3). The younger broods, however, feed to a larger extent on a small cumacée, *Diastylis Ratkei*, which is chiefly found among the *Nephthys-nitida* community.

In respect to Björkö Fjord it should be observed, in addition to what has been said in the introductory remarks, that the greatest depth of the channel approaches 30 metres. The plaice occur here as well as inward towards the shore in the shallow waters.

Björkö Fjord has not been investigated in recent years, for which reason I have had no opportunity of studying the distribution of the different communities of animal organisms in the localities where the plaice mainly occur. The communities of *Echino-*

Table 3. Stomach Contents in Plaice from Stig Fjord.

Date	Depth, Bottom conditions	Length in cm.	Stomach contents
$^{21}/_{10}$ 1922	12 m. (clay)	10	Diastylis ratkei, several species.
—	—	10	Indeterminable.
—	—	13	Shell remnants.
—	—	14	— —
—	—	14	Indeterminable.
—	—	14	Empty.
—	—	15	Shell remnants.
—	—	16	Diastylis ratkei (several).
—	—	16	— — + shell remnants.
—	—	16	— —
—	—	17	Rissoa shell.
—	—	17	Shell remnants (Syndosmya alba?).
—	—	17	Diastylis ratkei.
—	—	25	Syndosmya alba.
—	—	28	— —
—	—	28	Empty.
$^{1}/_{12}$ 1924	7 m. (clay)	21	Syndosmya alba, Macoma baltica.
—	—	25	— —
—	—	25	— — (en masse), Macoma.
—	—	26	— — , Philine.
—	—	26	— —
—	—	26	— — , Philine, polychaetes remnants.
—	—	27	— —
—	—	28	— — , Macoma.
—	—	30	— — , Philine.
—	—	31	— — , Scalibregma. Arenicola.
$^{29}/_{10}$ 1925	7 m. (sand-mixed bottom)	13	Diastylis ratkei, Syndosmya, Nucula nitida.
—	—	13	— — , Pectinaria.
—	—	13	— — , Nucula remnants.
—	—	15	Syndosmya nitida + alba, Mya.
—	—	16	Cultellus pellucidus, Nucula nitida, Spisula, Cardium.
—	—	16	Diastylis, Corbula gibba, Syndosmya nitida.
—	—	17	Mytilus, Corbula, Syndosmya nitida.
—	—	17	Nereis, Nucula nitida, Syndosmya alba.
—	—	21	Syndosmya nitida.
—	—	21	Nephthys, Philine, Cultellus, Spisula, Nucula, Syndosmya.
—	—	22	Cultellus, Syndosmya nitida.
—	—	23	Nephthys, Terebellides.
—	—	25	Syndosmya nitida.

cardium-filiformis and *Brissopsis-Chiajei* seem to be characteristic of the deeper regions of the fjord.

As regards the food conditions of the plaice in general and the different communities of animal organisms in the fjords, it is evident that the plaice are able to a great extent to adapt themselves to the changing conditions which prevail. Thus, they seem to utilize to an equal degree the wholesale production by the *Abra* communities of *Syndosmya* (*Abra*) *alba* and the abundant occurrence of *Amphiura filiformis* within the *Echinocardium-filiformis* community, to mention only a few instances.

It can thus scarcely be said that the plaice in the Bohusläns Fjords absolutely depend upon a definite bottom fauna, even though within the different fjords they seem to prefer certain associations. Obviously, the bottom conditions on the whole and the hydrographical conditions also play a considerable rôle.

2. The Stock of Plaice in the different Fjords.

Since 1895 the plaice in the Bohusläns Fjords have been protected from Danish-seine fishery and, since 1900, from trawl-fishery. The stock has thereby been able to develop without being disturbed by such intensive fishery. It is true that plaice have been caught in nets in most of the fjords, and, when fishing for sprat and mackerel with purse-seine and shore-seine, plaice have also occasionally been taken, but this fishing has presumably had no effect on the stock. The fluctuations — often very pronounced ones — in the density of the stock from year to year can hardly to any considerable extent be attributed to the influence of the fishery inside the "Skärgård". These fluctuations are no doubt chiefly due to certain factors which will be dealt with in the following pages.

The previous investigations on the plaice in the Bohuslän Fjords are confined to the fishing experiments undertaken by Trybom (in 1903, 1905 and 1908), chiefly in connection with marking and releasing of plaice caught in the Kattegat and Skagerak. In 1920 investigations of the plaice stock in the fjords were resumed. During the first year they were carried out onboard a hired fishing vessel, but later the Research Vessel the "Skagerak" was employed, and expeditions in these fjords have been repeated each year from 1921 to 1929, though at somewhat different seasons (Table 4).

Table 4 shows to what extent the fjords were examined. Stig Fjord was most regularly investigated. The results of the catches in Askerö-, Havsten-, Kalvö- and Kolje-Fjords were for the most part negative and are therefore not included.

Different implements were employed in the investigations, which should be borne in mind when comparing the different results of the catches. In most cases the implements used were fish-trawl and Danish-seine, the latter being mostly of the fine-meshed type usually called the haddock-seine. Even the shrimp-trawl was used in some cases. For the size of the gear, the size of the meshes, etc., refer to Table 5.

A direct comparison between the catches made by different implements is possible only in a few instances. Thus it has proved possible, in places where the stock was dense, by one single haul with the Danish seine to capture as large a number of plaice

Table 4. Catches of Plaice in the Bohuslän Fjords per Trawling Hour or per Haul (Danish Seine) at the Fishing Experiments in the Period 1920 to 1929.

Year	Month	Implement	Åby Fjord	Bro Fjord	Outer Gullmar Fjord (Threshold)	Inner Gullmar Fjord (Färlef Fjord)	Ellös Fjord	Stig Fjord	Marstrand Fjord Hake Fjord	Björkö Fjord	Remarks
			20 m.	28-35 m.	20-35 m.	30-35 m.	12-16 m.	7-20 m.	. .	10-29 m.	
1920	October	Danish seine	..	55	..	44	..	..	54	128	flat-fish seine
1921	February	Fish trawl	..	..	..	45	..	..	..	31	
—	October	—	..	77	..	31	..	144	..	145	
1922	October	—	..	60	..	32	..	942	..	..	
—	Decbr.	—	..	..	..	..	153	..	..	..	
1923	March	—	70	..	..	..	..	..	..	..	
—	July	—	..	..	..	7	..	..	..	..	
—	Septbr.	Danish seine	..	..	..	31	..	427	..	..	haddock seine
1924	Septbr.	—	..	..	..	..	..	214	..	..	— —
1925	October	—	6	6	35	..	8	76	..	..	— —
—	November	—	11	..	26	..	..	..	..	..	
1926	March	Fish trawl	..	36	..	4	..	..	..	..	
—	Septbr.	Danish seine	1	10	..	..	..	94	..	..	haddock seine[1])
1927	Septbr.	Shrimp trawl	..	..	..	..	..	90	..	..	— —
—	—	Danish seine	3	2	129	—	0	26	..	..	
1928	March	Fish trawl	..	..	10	..	..	17	..	..	
1929	July	Shrimp trawl	..	..	110	..	..	..	..	..	
—	August	—	..	..	..	..	..	564	..	..	
—	—	Fish trawl	43	22	..	5	..	306	..	..	

[1]) codend lined with fine-meshed seine-cloth.

as could be caught in one hour's trawling with the fish-trawl. On the other hand, in less densely populated fishing grounds, on hour's trawling produced a far better result than one haul with the seine. The shrimp trawl is considerably smaller in size than the fish-trawl, but in the narrow waters inside the fjords, where the larger trawls can scarcely be manipulated, the shrimp-trawl is very useful, yielding in certain cases even more abundant catches than the larger trawls, particularly in places where small-sized plaice occur, which are more easily caught with the fine-meshed nets.

For the investigations undertaken last summer concerning the distribution in the fjords of the 0- and I-groups of plaice, a smaller fine-meshed trawl was employed "young-fish trawl" (Table 5), which, like the young-fish trawl designed by Dr. JOHANSEN, could be dragged from a small motor boat in shallow waters. The trawl used in these experiments was larger than the one used by Dr. JOHANSEN, but repeated experiments showed that in respect of catching capacity it corresponds very nearly with the latter.

Owing to the facts that our investigations were made chiefly in the deeper regions of the fjords, where plaice were found, and that the gear used was as a rule coarse-meshed (trawl, Danish seine), the larger proportion of the plaice caught belonged to Groups II, III, and IV. Only in Stig Fjord was Group I also present in large numbers in the catches. Any more thorough investigation of the vertical distribution of the plaice could thus not be carried through, but it would appear even from the previous chapter that the youngest groups — 0 and I — occur, at any rate at certain seasons, on shallows of from one to one half metre's water and that the plaice grows in size as the water becomes deeper. The migrations from deep to shallow waters — and vice versa — occur, however, at different seasons, for which reason the distribution of plaice at the different seasons of the year may vary considerably; this, too, partly accounts for the great fluctuations which are frequently noted in catches made in a given fjord and in a given locality.

The quantitative distribution of the plaice in the fjords is shown, on the whole, in Table 4, from which appears that it is far from uniform. It is seen, moreover, that certain fjords to a much greater extent than others seem to be frequented by the plaice. Amongst the best fjords in this respect is, no doubt, Stig Fjord, but very good stocks have also been found in the outer waters of Gullmar Fjord, in Ellös Fjord, and Björkö Fjord in the different years. Even though the fluctuations of the stocks in the different fjords do not correspond exactly as far as the different periods are concerned, the term of years 1920 to 1924 evidently shows a considerably more numerous stock of plaice than the immediately following years. This increase of the stock is undoubtedly connected with the development of the stronger year-classes (Table 6), such as those of 1919, 1920 and 1921. The distinct decrease of the stock in the period of 1925 to 1928 seems, in its turn, to be due to weaker broods. In 1929 there is again an obvious improvement of the stock in Stig Fjord, which is probably due to the development of a new stronger brood of 1927. Thus it seems to be beyond all doubt that as regards the periodic fluctuations in the plaice stock, which have been established in the fjords, the predominant causative factor is the varying strength of the year-classes (Table 6).

Another question which arises is whether the fluctuations in the strength of the plaice stock in the fjords correspond to similar fluctuations in the stock out at sea, or, in other words, whether the fjord stock can be taken as an index of the strength of the plaice stock and its possibilities of development in the open sea outside the Skärgård. It has already been pointed out that certain broods — particularly the 1919 year-class, as also the 1920 and 1921 — have played a great part in the fjord stock. Of these the 1919 year-class (Heincke and Bückman 1926) and also the 1920 to 1922 classes have been favourable also outside the Skärgård (Jensen 1928). The favourable year-classes of the fjords seem thus to have their counterpart in favourable broods both in Skagerak and the North Sea.

If we plot a curve — as has been done in Fig. 1 — of the catches (1920 to 1929) in the fjords — that is the mean catches in the seasons summer to autumn for all the fjords, disregarding the different catching capacity of the various implements — and also a curve of the output of the Danish plaice fishery in the Skagerak 1920 to 1927,

these two curves will be found to agree with one another for the years 1921 to 1924. The catches made in the fjords during these years correspond fairly well quantitatively with the annual fluctuations in the fishery yield in the Skagerak. In 1925 to 1927, when the fjord-stock of plaice was very poor, the annual catches of plaice in the Skagerak were, however, considerably larger than in the immediately preceding years. This may have some connection with the fact that — as will be shown in the following pages — the plaice do not spawn in the fjords, but, towards the time when they are mature, they migrate out of the fjords, thus creating a diminution of the fjord-stock, if this is not

Fig. 1.
——— Average Catch of Plaice per Fishing Experiments (Table 4) in the Fjords of Bohuslän (1920—1929).
— — — The total Yield in Tons of Danish Plaice Fishery in the Skagerak (1920—1927).

Table 5. Fishing-Gear, Size and Mesh-Width (Double Post-Length).

	Fish trawl	Danish seine (Haddock seine)	Shrimp trawl	Young-fish trawl I	Young-fish trawl II (Johansen)
Headline-length in metres	27.0	28.0	18.0	15.4	7.7
Footrope-length in metres	39.5	28.0	21.4	14.3	7.8
Mesh-size in centimetres:—					
Wings	13.6	..	3.0	1.8	1.9
Square	12.0—13.2	..	..	..	..
Bating	7.0—11.4	..	..	..	..
Belly	7.0—11.4	..	..	..	..
Codend	5.8	..	..	..	..
Wings and square	..	10.3	3.0	1.8	1.9
The middle	..	6.5	3.0	1.8	1.9
Codend	..	6.4	3.0	1.8	1.2

Table 6. Distribution of different Year-Classes of Plaice in the Bohuslän Fjords in the Years 1922 to 1929.

(The figures within brackets are percentages.)

Fjords	Date	Number of plaice belonging to Year-class													Total
		1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	
Åby Fjord	March 1923	..	2 (2.3)	4 (4.7)	*72* (*84.7*)	7 (8.3)	..	..	..	..	..	..	..	..	85
—	July 1929	..	..	..	..	..	..	..	..	1 (3.3)	5 (16.6)	12 (40.0)	11 (36.6)	1 (3.3)	30
Bro Fjord	Octbr. 1922	1 (1.0)	4 (4.1)	26 (26.8)	*60* (*61.8*)	6 (6.2)	..	..	..	..	..	..	..	..	97
—	March 1926	..	..	..	..	..	7 (26.9)	16 (61.5)	13 (11.6)	..	..	..	..	..	26
Gullmar Fjord (Färlef Fjord)	Octbr. 1922	1 (1.3)	6 (8.1)	24 (32.4)	*42* (*56.7*)	1 (1.3)	..	..	..	..	..	..	..	..	74
Gullmar Fjord (Threshold)	March 1926	..	..	..	..	1 (20.0)	1 (20.0)	..	1 (20.0)	2 (40.0)	..	..	..	..	5
Gullmar Fjord	June 1923	..	..	4 (13.3)	*20* (*66.6*)	5 (16.6)	1 (3.3)	..	..	..	..	..	..	..	30
Ellös Fjord	Decbr. 1922	..	..	4 (4.3)	*83* (*89.2*)	6 (6.5)	..	..	..	..	..	..	..	..	93
Stig Fjord	Octbr. 1922	..	..	..	10 (9.1)	*39* (*35.7*)	*60* (*53.2*)	..	..	..	..	..	..	..	109
—	Decbr. 1924	..	..	..	..	29 (*45.3*)	35 (*54.7*)	..	..	..	..	..	..	..	64
—	Septbr. 1926	..	..	..	..	..	..	4 (6.3)	8 (12.6)	*46* (*73.0*)	5 (8.1)	..	..	..	63
—	Septbr. 1927	..	..	..	..	..	..	..	..	3 (4.1)	56 (*95.9*)	..	..	..	59
—	August 1929	..	..	..	..	..	..	..	..	..	..	2 (2.6)	50 (*65.7*)	24 (31.7)	76
Björkö Fjord	Novbr. 1922	..	..	1 (16.6)	*5* (*83.4*)	..	..	..	..	..	..	..	..	..	6
		2	12	63	292	94	104	20	82	52	66	14	61	25	..

recruited by new broods. Owing to these conditions, a rich stock of any given year-class will last considerably longer out at sea than in the fjords. It is thus quite natural that the curves of Fig. 1 should intersect. Therefore, on the whole, the fjord-stock of plaice may be taken as an index of the stock outside the Skärgård. In this connection it should, however, be observed that the stocks of the different fjords — probably owing to irregularities of the immigration — may sometimes vary slightly as regards the abundance of one or other year-class, so that, taking for instance the stock of a single fjord as a basis, one should be a little vary in drawing conclusions as to the abundance of the stock outside the Skärgård. It appears for instance from Table 6 that the year-classes 1920 and 1921 — which played a dominant part in Stig Fjord — were not very con-

spicuous in the other fjords. Also, the stock of plaice in the year 1927 was a fairly favourable one in the outer parts of Gullmar Fjord, whilst it was rather unimportant in the other fjords. The appearance in, and immigration into the different fjords of the 0-group also show great variations, as appears further from Table 7.

During the summer of 1929 — as has been mentioned — a series of trawlings with a fine-meshed trawl were undertaken in the fjords, with the purpose of catching, chiefly, plaice belonging to the 0- and I-groups. As far as possible the hauls lasted 30 minutes and even though the bottom conditions in many places permitted only of shorter hauls of 10 to 15 minutes, the catches have been calculated as 30 minute hauls.

Table 7. Occurrence of the 0- and I-Groups of Plaice in August 1929 in the Bohuslän Fjords per 30 Minutes' Haul.

Fjords	Station	Depth in metres	Number of Plaice belonging to			Mean Figure		
			0-gr.	I-gr.	II-gr.	0-gr.	I-gr.	II-gr.
Gullmar Fjord, outer	Dalsvik.....	1—1½	22	30	2	..	..	..
— —	Finsbo.....	1	15	0	0	..	..	..
— —	Bökevik	1	208	47	5	..	..	..
— —	Rödskär	1	120	27	0	..	..	..
— —	Högaröskär	1	10	80	0	*75*	*37*	*1*
— inner	Håbäck.....	½—1	21	18	0	..	..	..
— —	Little Bornö	1	8	4	0	..	..	..
— —	Great Bornö	1	16	15	0	*15*	*12*	*0*
Bro Fjord, outer.....	Skalhamn.....	2	15	18	..	*15*	*18*	*0*
— inner	Rixö	1	36	18	0	*36*	*18*	*0*
Åby Fjord, threshold.....	Nävekärr	1—1½	17	30	3	*17*	*30*	*3*
— inner	Risö-Germunderöd	..	12	2	0	*12*	*2*	*0*
Ellös Fjord.....	Källsnäs	1	252	12	3	..	..	..
—	Almvik	1	165	10	0	..	..	..
—	Gullbergsvik.....	1	30	0	0	*149*	*7*	*1*
Stig Fjord, outer	Vikskile.....	½—1	24	0	0	*24*	*0*	*0*
— inner.....	Erholmen.....	1	3	3	3	*3*	*3*	*3*

The distribution of the year's fry and last year's brood, 0- and I-groups of plaice, reflects quite well the general abundance of the stock according to Table 4. Nevertheless, the occurrence of the 0-group in Stig Fjord in the year 1929 seems to fall considerably short of expectation, since the stock is usually more abundant in this fjord than in any of the other fjords. Whether this is due to chance or not, is difficult to decide on the basis of the few data at hand. But, if we compare the distribution in Stig Fjord with that of the other long fjords, for instance Gullmar Fjord, it will be observed that it is chiefly in the outer parts of these that the larger number occur, and the 0-group is as a rule even considerably stronger than the I-group in these parts. If we turn our attention to the inner parts of the fjords this relation between the 0- and I-groups by no means

exists, but group I is proportionally better represented. No plaice of group I were found at the mouth of Stig Fjord, but off the Erholmen they were found in fairly large number.

These instances possibly indicate that the immigration into Stig Fjord had not really commenced at the time when the investigations were made. The fjord is separated from the Skärgård outside by narrow sounds, and is therefore perhaps comparable for instance with the inner parts of the long Gullmar Fjord, where group I is so scantily represented as compared with the outer parts of the same fjord.

It is obvious that one cannot from one year's investigations form any definite conception as to whether the broods are abundant or not. The highly varying bottom conditions even warrant a comparison between different fjords and different localities within them.

3. The Composition of the Plaice Stock.

It has already been pointed out, in the previous chapter, that the stocks of the different fjords to a certain degree display variations as regards the occurrence of the year-classes. It is found, moreover, that the different length-classes may be very differently represented in the stocks, and that the different fjords usually harbour plaice of fairly definite size-groups.

Figs. 2 to 6 give a series of diagrams representing the composition of the stocks in the different fjords. We see, first, that the stocks are composed of highly varying size-classes. A comparison, for instance, between the stocks of Färlef Fjord (Fig. 2) and Stig Fjord (Fig. 3) shows that the bulk of the plaice in Färlef Fjord range between 35 and 40 cm., a not inconsiderable number even exceeding this limit, whilst in Stig Fjord only a minority of the plaice caught measure more than 30 cm. The majority of the plaice in this fjord range between 20 and 30 cm., and in certain years, a great number are even below 20 cm. In Bro Fjord (Fig. 4) and Björkö Fjord (Fig. 5) the conditions are more like those in Färlef Fjord, although the best represented size-classes range between 30 to 35 cm. In Åby Fjord (Fig. 6) and Ellös Fjord (Fig. 6) the plaice caught are on an average somewhat smaller in size (1922 to 1923).

We also observe, if we follow the stock during a number of years, that the percentage abundance of the size-classes varies from year to year, but that the plaice attain a certain fairly definite size — varying for the different fjords — and then disappear from the stock altogether, being replaced by smaller individuals. Thus, for instance, the plaice in Färlef Fjord usually obtain a length of 40 to 45 cm., while in Stig Fjord they rarely become more than 30 cm. Fig. 3, particularly, gives the observer a very distinct impression that definite alterations in the size of the plaice occur during a number of years up to a certain limit, eventually resulting in the disappearance of the

Explanation of the Figures 2—4 (see p. 66).

Fig. 2. Diagram showing the Stock of Plaice in the Färlef Fjord, October 1920—1922.
Fig. 3. Diagram showing the Stock of Plaice in Stig Fjord 1901, 1921—1929.
Fig. 4. Diagram showing the Stock of Plaice in the Bro Fjord, October 1920—1922.
Plaice not measuring 20 cm. are not included in the diagrams.

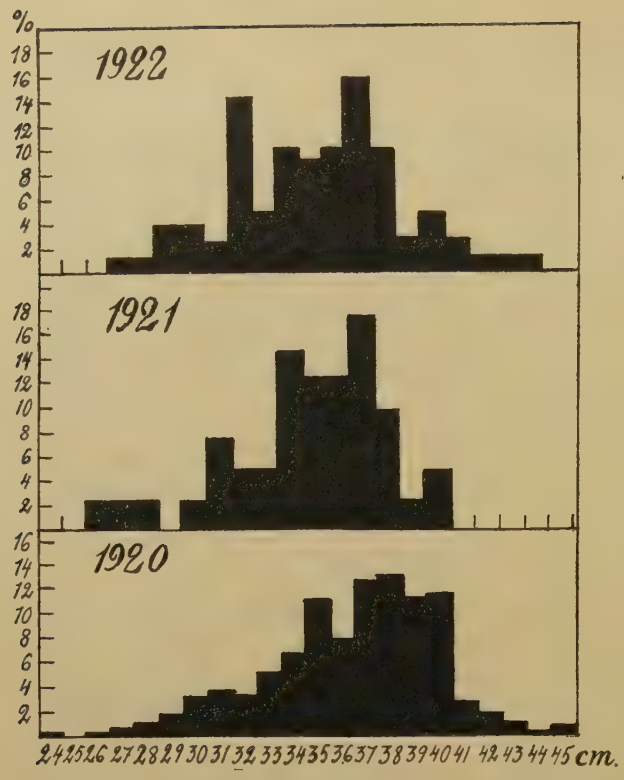

Fig. 2.

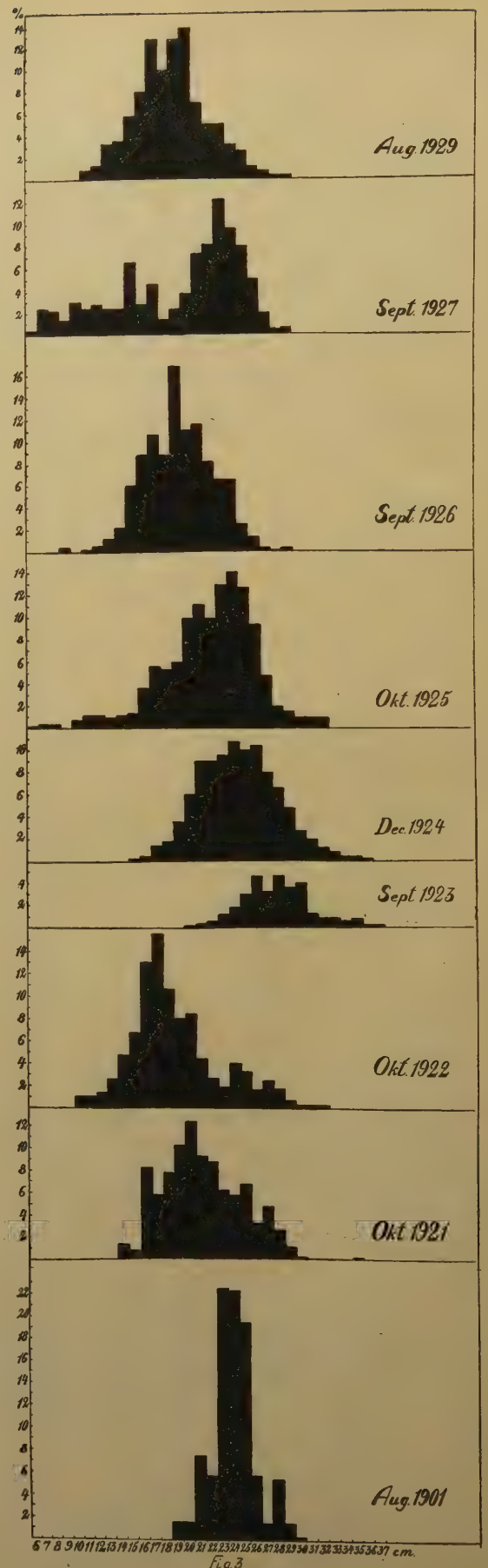

Fig. 3.

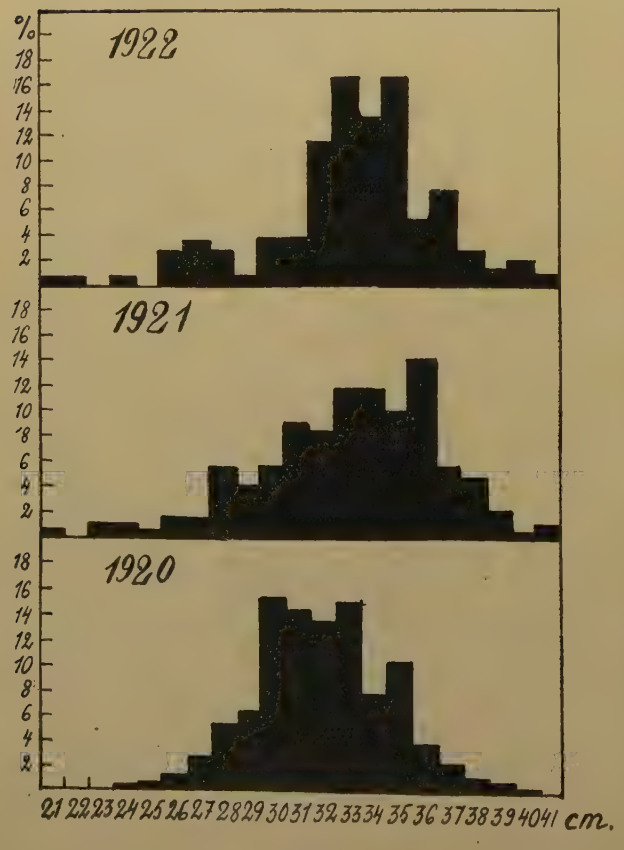

Fig. 4.

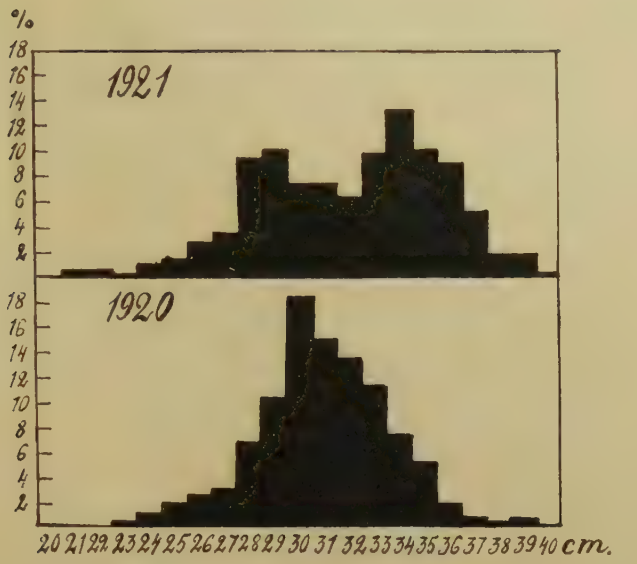

Fig. 5. Diagram showing the Stock of Plaice in the Björkö Fjord, October 1920—1921.

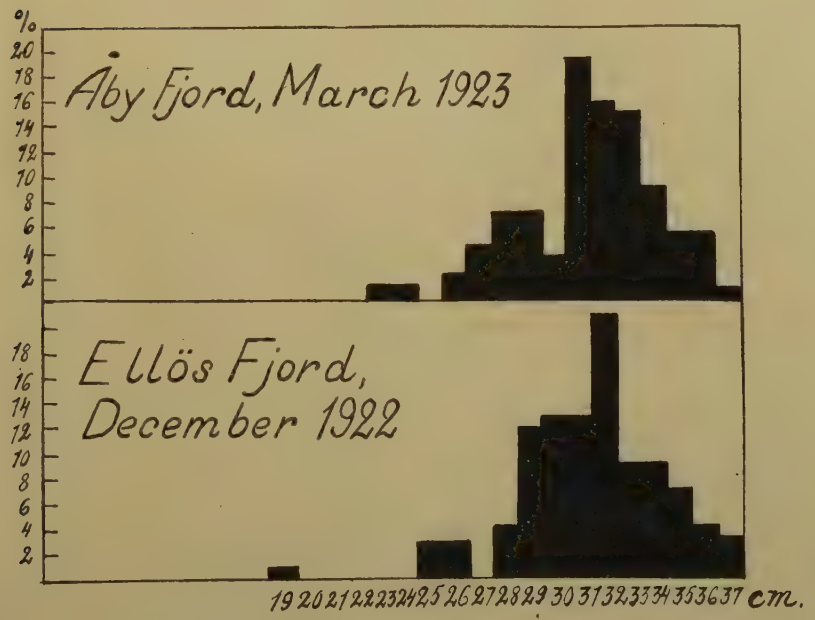

Fig. 6. Diagram showing the Stock of Plaice in the Åby Fjord, March 1923, and in the Ellös Fjord, December 1922.

older and larger individuals, these being replaced by younger and smaller ones, the same phenomenon being again repeated. Fig. 3 gives several clear examples of this. Then, in 1922, a strong invasion of plaice of 15 to 20 cm. length occured. In 1923 to 1924 a shifting in the direction of larger size-classes again took place, the individuals even exceeding 30 cm. In 1925 these large individuals again distinctly began to migrate, as also in 1926, when, however, a new more marked invasion of smaller plaice appeared, which, in 1927 attained a greater length; the 1929 stock resembled very much that of 1922. Similar instances were observed in other fjords (Figs. 2, 4, and 5), although the conditions in Stig Fjord seem to have shown more regularity.

What has been discovered from the above as regards size-classes may be summarized as follows:— 1) the plaice stock in the fjords does not seem to contain individuals of above a certain maximum size, which, however, varies somewhat in the different fjords, as does also the mean size of the plaice. 2) as plaice exceeding a certain size do not occur in the fjords, they must have emigrated.

By means of marking experiments, which will be further discussed in the following pages, a distinct impression is gained as to the character and significance of these migrations.

4. Marking of the Plaice for the Purpose of Studying its Migrations.

In the Bro- Stig- and Björkö Fjords 200 individual plaice were marked in each fjord in October 1921. By the end of May 1924, 238 individuals — or 39.7 per cent. — had been recaptured. The majority of the recaptured fish were obtained before the close of 1922, a large number being caught already during the first months after liberation; 7 were taken in 1923 and 2 in 1924. Of the 200 plaice released in Bro Fjord 85 — or 42.5 per cent. — were recaptured, 61 of which were caught outside the Skärgård and 24 in the fjord proper. The majority were caught between April 1922 and November of the same year. 3 individuals were recaptured in 1923 and 1 in 1925, all outside the Skärgård and after long migrations. Of the plaice which had been marked in Stig Fjord 69 individuals — or 34.5 per cent. — were recaptured; of these only 4 had left the fjord and migrated outside the Skärgård. The majority of the marked plaice in this fjord were, however, considerably younger and smaller than in the two other fjords. One plaice had migrated from Stig Fjord to Kolje Fjord, north of the Orust isle. 84 individuals — or 42 per cent. — of the plaice marked in Björkö Fjord were recaptured. Of these 28 individuals had left the fjord district proper and gone outside the Skärgård, while 56 were recaptured in the fjord proper or in adjacent districts within the Skärgård. 42 were fished in Björkö Fjord proper. As regards the plaice belonging to this fjord the greater number were caught also in the period April to November 1922, a large proportion being taken in the fjord proper already during the first winter after their liberation. In January 1923 one marked specimen was obtained in the fjord, while 2 were taken outside the Skärgård in February and April 1923 and 1 in May 1924. Of the latter groups, 2 were taken right out in the North Sea.

Of the recaptured marked plaice, which had left the fjords at all, — 38.9 per cent.

— a relatively small number had migrated to other fjord-districts within the Skärgård. The large majority had migrated into the open sea. The migrations of these plaice can easily be followed in the Charts (Chart II). A fairly large number were naturally recaptured off the Swedish coast immediately outside the fjords, frequently within the districts where the usual spawning grounds of the plaice are found. Such plaice districts are found farther to the North for instance from Marstrand Fjord up to Hållö Light-house, and to the South from Vinga Light-house down to Kungsbacka Fjord. The distribution of the plaice, which had migrated from these various fjords, was, however, far from being uniform in these districts. The plaice belonging to Bro Fjord were again encountered outside the entrance to Malmö Fjord and upon the shoals outside Gullmar Fjord, as also down towards the Herman Isle and the Måse Rocks. The Björkö Fjord plaice were mostly taken to the South of the fjord in the Vinga tract and also down towards the Tistlar Islets and Kungsbacka Fjord, but a fair number had even migrated through the northern branch of the fjord, finding their way up towards the district of the Marstrand Fjord.

The unequal distribution outside the Skärgård of the plaice stocks of the different fjords, which is so distinctly marked already near the Swedish coast, is found again if we follow the plaice on their further migrations. The majority of the emigrating plaice had found their way as far as the Skaw district (Aalbæk Bay) and out into the North Sea, where the greater part had even gone as far as the Heligoland Bay. Both the latter region and the Skaw tract are important spawning grounds for plaice. Of the fish migrating from the fjords (93 individuals), 52 (55.9 per cent.) were recaptured off the Swedish coast, while 41 were taken within other districts — i.e. 19 at the Skaw (20.4 per cent.), 2 off the Hirtsholmen and Læsø Channel (2.1 per cent.), 3 off Hirtshals (3.2 per cent.), 1 off Hanstholm (1.0 per cent.), and 14 in the North Sea (15.1 per cent.); of the latter 7 were taken in Heligoland Bay and 2 off the south-western coast of Norway. Of the plaice caught in the Skaw district, 10 specimens had migrated there from Björkö Fjord, 2 from Stig Fjord, and 7 from Bro Fjord. Individuals from Bro Fjord were, however, also taken near Hirtsholm and in the Læsø Channel. Among the plaice which had migrated further west, those of the latter fjord were decidedly in majority. Out of 20 individuals taken to the west of the Skaw district proper 15 were from Bro Fjord. Of the 3 individuals from Björkö Fjord, taken in the North Sea, the two were not recaptured until two and three years, respectively, after their emigration — whilst the specimens migrating to these parts from Bro Fjord, with a single exception, were caught within a year after liberation. Thus the plaice from Bro Fjord seem to prefer a considerably more westerly direction for their migrations than those from Björkö Fjord and Stig Fjord, of which the majority had collected near the Skaw district. Of the plaice migrating from the Swedish fjords, 25.4 per cent. thus had gone to the Skaw district (including those which were caught off Læsø, Hirtsholmen and Hirtshals), and 15 per cent. to the North Sea. As the spawning of the plaice takes place only to a slight extent in the coastal waters of Sweden, a considerable portion of the fish encountered in these parts (55.9 per cent.) would probably have continued their migrations to the same districts. It therefore seems highly

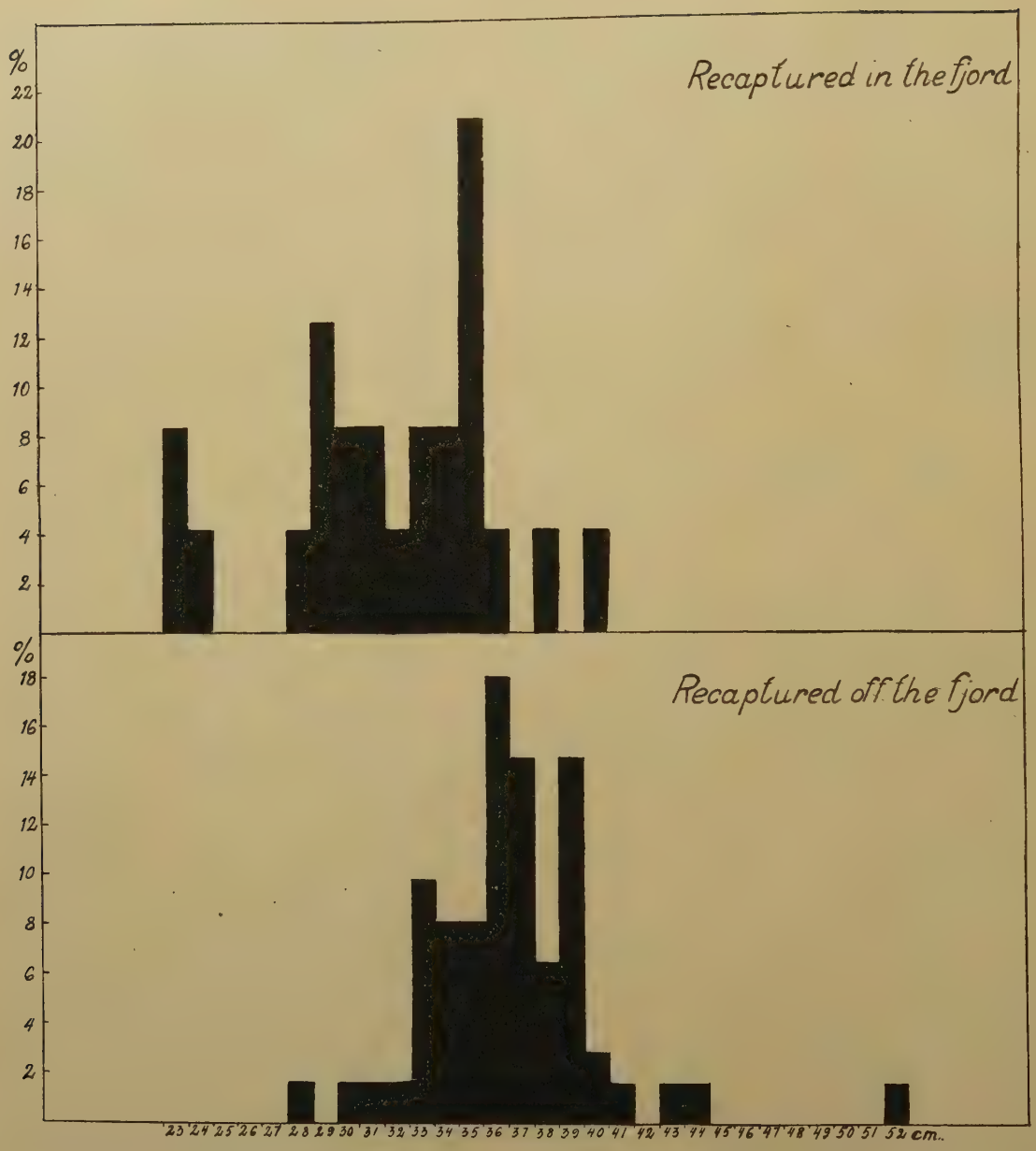

Fig. 7. Diagram showing the Stock of recaptured Plaice marked in the Bro Fjord.

warrantable to assert that the major part of the plaice bred in the Bohuslän fjords emigrate from the Swedish coasts.

Further, as regards results, these marking experiments confirm the data collected long ago by Danish markings, which showed that a lively interchange takes place between the plaice stocks of the Skagerak, the Northern Kattegat, and the

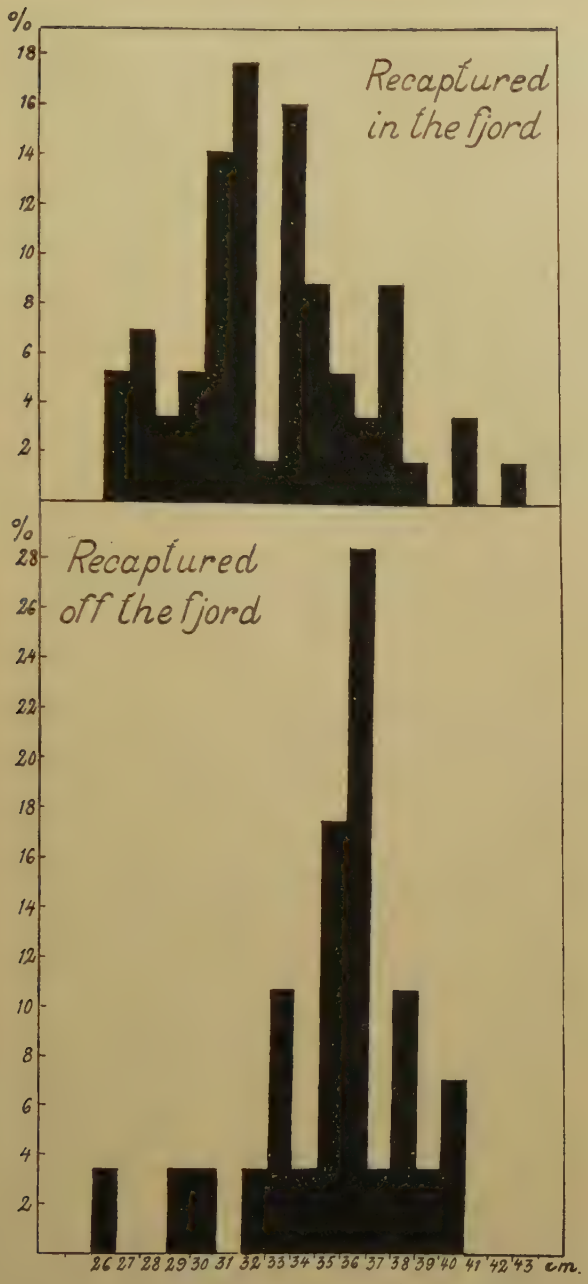

Fig. 8. Diagram showing the Stock of recaptured Plaice marked in the Björkö Fjord.

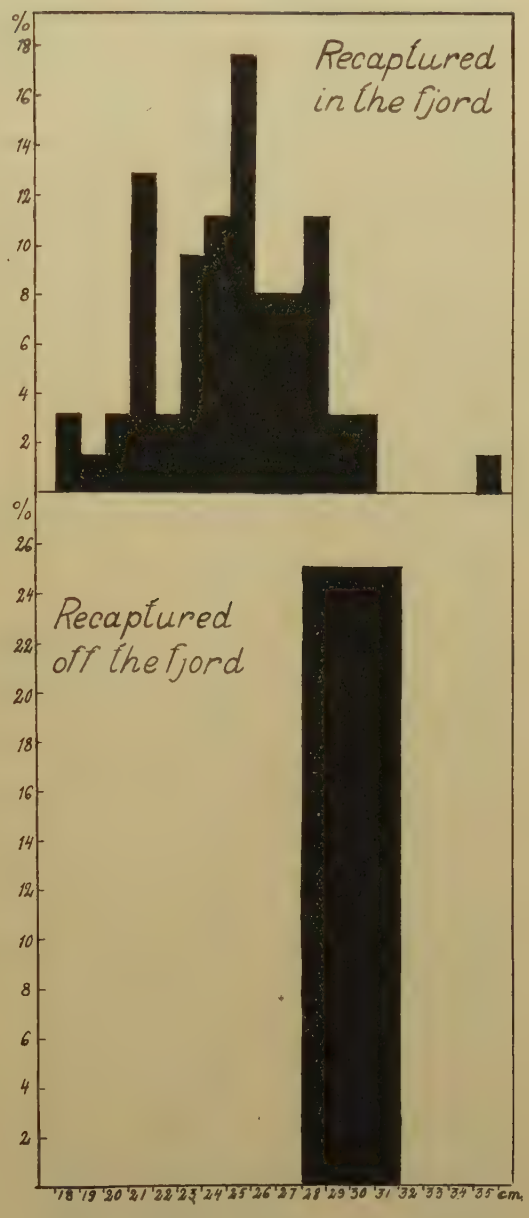

Fig. 9. Diagram showing the Stock of recaptured Plaice marked in the Stig Fjord.

North Sea. It is, however, interesting to note that the plaice stocks in the Bohuslän fjords direct their migrations to a great extent towards the Skaw and North Sea districts, visiting the areas where we find important spawning grounds.

On comparing the size of those recaptured plaice which had left the fjord districts and those which had remained within them, we find a pronounced distinction, the latter being, on an average, considerably smaller than the former (Figs. 7 and 8). This was very apparent both in Bro and Björkö Fjord. Thus it was the larger and older plaice which had emigrated. The figures show that occasionally a larger plaice was recaptured also within the Skärgård. These larger individuals were usually caught immediately after marking. If we further compare the figures more thoroughly, it will appear that the marked plaice recaptured outside the Skärgård were recruited chiefly from those very size-groups which in the fjords inside the Skärgård are least frequent, and which show a rapid decline in their numbers. We have here an explanation of the great decrease in the number of large plaice in the fjords. The plaice which had emigrated from Björkö Fjord had a somewhat smaller average size than the corresponding plaice from Bro Fjord; this holds good, to a still greater extent, of the plaice from Stig Fjord (Fig. 9). This is due to the varying growth-rate, to which I shall take an opportunity of returning later.

The questions which present themselves now are the following:— What is the cause of this marked distinction between the fjord-stocks and the plaice caught outside the Skärgård, and to which factors can we ascribe the emigration of the large plaice from the fjords.

5. The Spawning of the Plaice.

If we investigate the distribution of the different year-classes of plaice in the different fjords — as given in Table 8 — we shall se how sparse is the number of older plaice as compared with the number of younger ones.

Table 8. The Distribution of the Different Year-classes in the Fjords.

Fjord	Date	Groups					
		I	II	III	IV	V	VI
Åby Fjord	March 1923	..	..	7	72	4	2
—	July 1929	1	11	12	5	1	..
Bro Fjord	October 1922	..	6	60	26	4	1
—	March 1926	..	..	3	16	7	..
—	March 1930	..	..	6	12	5	..
Gullmar Fjord (Färlef Fd.)	October 1922	..	1	42	24	6	1
— —	March 1926	..	2	1	..	1	1
— (Threshold)	June 1923	..	1	5	20	4	..
— —	March 1930	..	1	36	23	..	1
Ellös Fjord	Decbr. 1922	..	6	83	4	..	..
Stig Fjord	October 1922	60	39	10	..	..	..
—	Decbr. 1924	..	..	35	29	..	..
—	Septbr. 1926	5	46	8	4	..	..
—	Septbr. 1927	..	56	3	..	..	..
—	August 1929	24	50	2	..	..	..
Björkö Fjord	Novbr. 1922	..	..	5	1	..	..

Only a minority of the plaice belong to Group V or older groups, Group IV being usually the oldest one represented, to any considerable extent, in the catches. In Stig Fjord a marked decrease in number seems to take place from Group III upwards. If we compare this observation concerning the distribution of the year-classes, on the one hand with Figs. 2 to 6 — showing the size distribution in the fjords — and, on the other hand with the size of the emigrating plaice (according to Figs. 7 to 9), it is evident that the plaice emigrate when they attain a definite age and size — which vary in the different fjords — that is, at the time when sexual maturity is reached, for, it is only exceptionally that we encounter plaice with developed gonads in the fjords. This may happen, usually in February, March, and April in the inner and more remote parts of the larger fjords, such as Färlef Fjord, that is the inner part of Gullmar Fjord, and in Havsten Fjord. Only a very small number of mature females were encountered here, the majority of which were evidently on their way out of the fjord. Mature males, on the other hand, are apparently very rare — at any rate I have not been able so far to obtain one single specimen. In the inner parts of the Bohuslän fjord-system the females are in absolute majority; just as in the larger number of fjords, on the whole, they predominate considerably in number over the males (Table 9). In the older groups, too, (V and VI) the females always predominate (72 to 83 per cent.). In the spring older males are still more rare (17 to 0 per cent., respectively). Plaice with gonads developed further than Stage III were on the whole very rarely encountered in the fjords, and such were found only in the autumn (Table 9). All this distinctly indicates that plaice do not spawn inside the fjords but must emigrate before the spawning period.

Table 9. Development of the Gonads in Plaice in the Bohuslän Fjords.

Locality	Date	Males					Females				
		Stages				Total	Stages				Total
		I	II	III	IV		I	II	III	IV	
Färlef Fjord	October 1922	12	8	7	..	27	23	12	8	..	43
Bro Fjord.....	—	24	18	1	..	43	46	2	4	1	53
—	March 1926	14	..	..	..	14	5	18	..	..	23
Åby Fjord.....	March 1923	42	..	..	..	42	43	..	..	..	43
Ellö Fjord	Decbr. 1922	18	14	1	..	33	63	3	..	..	66
Stig Fjord	Octbr. 1922	55	1	..	..	56	47	..	..	..	47
—	Septbr. 1926	24	1	..	..	25	37	4	1	..	42
—	Septbr. 1927	19	7	..	..	26	16	17	..	..	33
—	August 1929	29	1	..	..	30	40	10	..	..	50

Eggs of plaice occur very sparsely in the fjords. So far we have not succeeded in obtaining such except at the entrance to Gullmar Fjord (Tables 10 and 11) and even there in very scanty number. And, probably, the eggs in question had been carried inwards from the open sea by the current.

Table 10. Eggs of Plaice obtained by means of the "Scherbrutnetz" (Dip-net) per 20-minutes' Haul at the Mouth of Gullmar Fjord (the Threshold).

Date	Depth in metres	Eggs of Plaice	Eggs of other Fish
March 29th, 1926	1	0	41
— —	40	1	469
April 1st, 1926	1	0	21
— —	40	2	251
April 15th, 1926	40	0	72

Table 11 shows, furthermore, the negative results of hauls for plaice eggs in Stig and Bro Fjords. (Chart I).

Spawning plaice are found fairly regularly within certain districts off the Swedish west-coast, though nowhere in any considerable number. The coastal waters are as a rule too deep to afford suitable spawning-grounds for the plaice, and it is usually only where the shallower coastal plateau (of down to 50 m. depth) forms broader areas — such as those outside Gullmar Fjord, from Hållö Light-house and down towards Måse Rocks, between the Tistlar Isles and Kungsbacka Fjord, etc., — that spawning plaice are found at all. They occur in places where the depth ranges from 20 to 50 m., preferably at 30 to 40 m. depth. The scanty catches of spawning plaice obtained — of which the majority were females — permit, however, of the conclusion that, at any rate the coast off Bohuslän cannot be of any great importance as spawning ground for the plaice. This is confirmed moreover by the results of those dips (Chart I) which were undertaken off the coast stretching from Gothenburg towards the district of Gullmar Fjord (Table 11 A) in March—April 1928, and March 1930 (Table 11 B). Plaice eggs were very scanty. It seems therefore to be highly doubtful whether the frequently very abundant stocks of plaice in the fjords are to any great extent recruited from the spawning grounds off the Swedish coast. As pointed out by Dr. Johansen (1922), it is probable that for instance eggs and larvae from the North Sea are carried by the Jutland current into the Skagerak and northern Kattegat. Furthermore, it is probable that the spawning grounds within the Skaw district play a certain rôle for the stock on the Swedish side by means of eggs and larvae being carried by an eastward bound current towards the Swedish coastal waters and Bohuslän Fjords.

These investigations concerning the spawning of plaice thus seem distinctly to indicate that the plaice do not spawn in the fjords. The fjord-stocks must therefore be recruited from the open sea. The above recorded investigations upon the occurrence of plaice eggs show that an influx of eggs into the fjords does not take place to any considerable extent.

Some observations seem to indicate that an influx of plaice larvae into some fjords, which have a more open connection with the sea, does take place. The chief recruiting, however, is no doubt brought about by immigration of young bottom stages.

The course of this immigration appears distinctly from the previously mentioned

Table 11a. Results of Dips for Eggs of Plaice undertaken during March—April 1928.

Stat. Nr.	Position	Date	Depth in metres	Implement	Numb. of hauls	Eggs of plaice	Remarks
1	57°43′-11°31′	21/3 28	0—40	Hensen's egg-net	2	0	Outside Öcker Isle
-	—	31/3 -	0—40	1 metre's egg-net	2	0	
-	—	12/4 -	0—39	—	2	0	
2	57°52,5′-11°29′	21/3 -	0—40	—	2	0	Marstrand Fjord
-	—	30/3 -	0—40	—	2	0	
-	—	14/4 -	0—45	—	2	0	
3	58°1′-11°12,5′	12/4 -	0—57	—	2	0	Outside Marstrand Fjord
4	58°2,2′-11°23,5′	9/3 -	0—38	Hensen's egg-net	3	0	Outside Kråk Fjord
-	—	21/3 -	0—40	1 metre's egg-net	2	0	
-	—	30/3 -	0—36	—	2	0	
-	—	12/4 -	0—36	—	2	0	
5	58°3′-11°29,5′	21/3 -	0—22	—	2	0	Kråk Fjord
-	—	30/3 -	0—22	—	2	0	
-	—	12/4 -	0—22	—	2	0	
6	58°3,7′-11°32,1′	21/3 -	0—15	—	2	0	Outer Stig Fjord 1
-	—	30/3 -	0—15	—	2	0	
-	—	12/4 -	0—14	—	2	0	
7	58°4,4′-11°36,6′	21/3 -	0— 9	—	2	0	Inner Stig Fjord 27
-	—	30/3 -	0— 9	—	2	0	
-	—	12/4 -	0— 9	—	2	0	
8	58°14′-11°13,5′	9/3 -	0—50	Hensen's egg-net	1	0	Tova
-	—	22/3 -	0—55	1 metre's egg-net	2	0	
-	—	29/3 -	0—50	—	2	0	
-	—	11/4 -	0—50	—	2	0	
9	58°14,4′-11°25,5′	22/3 -	0—30	—	2	0	The Threshold
-	—	29/3 -	0—34	—	2	0	
-	—	12/4 -	0—34	—	2	0	
10	58°16′-11°27,6′	22/3 -	0—40	—	2	0	Mouth of Gullmar Fjord
-	—	29/3 -	0—39	—	2	0	
-	—	12/4 -	0—40	—	2	0	
11	58°16,5′-11°17,5′	22/3 -	0—32	—	2	0	West of the Trillingar
-	—	29/3 -	0—35	—	2	1?	
-	—	11/4 -	0—27	—	2	0	
12	58°18,5′-11°19,7′	22/3 -	0—37	—	2	0	Malmö Fjord
-	—	29/3 -	0—37	—	2	0	
-	—	11/4 -	0—37	—	2	0	
13	58°21,5′-11°25,2′	22/3 -	0—29	—	2	0	Bro Fjord
-	—	29/3 -	0—29	—	2	0	
-	—	11/4 -	0—30	—	2	0	

Table 11b. Results of Dips for Eggs of Plaice undertaken during March 1930.

Stat. Nr.	Position	Date	Depth in metres	Implement	Numb. of hauls	Eggs of plaice	Remarks
1	57°43′-11°31′	16/3 28	0—39	Hensen's egg-net	3	1?	Outside Öcker Isle
2	57°52,5′-11°29′	- -	0—38	—	3	0	Marstrand Fjord
3	58°1′-11°12,5′	- -	0—75	—	3	0	Outside Marstrand Fjord
4	58°2′-11°23,5′	- -	0—35	—	3	0	Outside Kråk Fjord
5	58°3′-11°29,5′	- -	0—20	—	3	0	Kråk Fjord
6	58°3,7′-11°32,1′	15/3 -	0—14	—	3	0	Outer Stig Fjord 1
7	58°4,4′-11°36,6′	- -	0— 6	—	3	0	Inner Stig Fjord 27
8	58°14′-11°13,5′	14/3 -	0—46	—	3	0	Tova
9	58°14,4′-11°25,5′	- -	0—50	—	3	1?	The Threshold
10	58°16′-11°27,6′	- -	0—25	—	3	0	Mouth of Gullmar Fjord
11	58°16,5′-11°17,5′	- -	0—40	—	3	0	West of the Trillingar
12	58°18,5′-11°19,7′	13/3 -	0—40	—	3	1	Malmö Fjord
13	58°21,5′-11°25,2′	- -	0—20	—	3	0	Bro Fjord
14	57°52′-11°21′	16/3 -	0—62	—	3	0	Outside Marstrand Fjord
15	57°55,7′-11°48′	- -	0—27	—	3	0	Hättan
16	57°43′-11°24,5′	- -	0—64	—	3	0	West of Öcker Isle
17	58°14,5′-11°8′	14/3 -	0—70	—	3	1	West of Tova
18	58°8,5′-11°16′	- -	0—40	—	3	1?	West of Herman Isle Head
19	58°11′-11°22,2′	- -	0—20	—	3	0	North Hättan

fact that the year's fry of plaice — the 0-group — first of all appear at the entrance to the fjords. Thus, for instance, the bottom stages occur already towards the end of May and the beginning of June in the outer parts of Gullmar Fjord (Table 12). In the inner parts of the fjords the 0-group appears considerably later (cp. p. 64 and Table 7), occurring on the whole, as already pointed out, only in small numbers in these regions. The immigration into and appearance of these young plaice upon the shallow banks of the mouth districts of the fjords may in certain years, when the spring and early summer are cold, be considerably delayed. In 1928 and 1929, for instance, such young plaice were very sparsely represented as late as the middle of June in the shallow localities at the entrance to Gullmar Fjord, where they otherwise used to appear regularly.

The causes of the fluctuations in respect to number and season of the immigration into the fjords might also be discussed in this connection. As an instance of these fluctuations the abundance of the 0-group of 1929 in Gullmar and Ellös Fjords, and the simultaneous scarcity of the same group in Stig Fjord, may be advanced.

On the assumption that eggs and larvae, particularly from the Danish waters, are carried in large numbers towards the Swedish coast by the current, it seems very likely that irregularities of the currents in these areas might give rise to irregularities in the immigrations of the plaice into the Bohuslän Fjords.

Table 12. Analysis of the Length of the 0-group of Plaice in May to July 1925 at the Entrance to Gullmar Fjord (Kristinebjerg) (cp. Fig. 11).

Date	Length in millimetres																				Total
	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	
$^{25}/_{5}$....	1	..	7	8	4	13	11	11	14	4	4	5	5	1	..	..	1	..	..	..	88
$^{10}/_{6}$....	..	1	1	1	2	2	3	4	3	..	2	5	4	2	2	3	1	1	..	1	38
$^{6}/_{7}$....	..	..	..	..	..	1	..	..	..	..	..	..	1	2	..	2	..	5	3	2	..

Date	Length in millimetres																				Total
	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	
$^{6}/_{7}$....	10	7	2	10	4	29	8	12	15	8	24	6	5	5	3	6	..	..	..	1	1	170

The Size and Growth-Rate of the Plaice in the different Fjords.

From Figs. 2 and 6 we saw that the curves representing the lengths of the plaice in the different fjords indicated great differences between the various stocks. While for instance the plaice in Färlef Fjord were very large, those of Stig Fjord were small. This difference is doubtless to some extent due to an unequal distribution of the year-classes in the catches made, but it depends chiefly upon differences in the growth-rate of the plaice. Even though these differences are most conspicuous when we compare the above-named fjords, they are still distinctly marked in other fjords as well.

In Table 13 the results of the investigations of the growth-rate of plaice in the Bohuslän Fjords are given. The growth-rate is apparently highly varying. Stig Fjord, in this respect, stands out distinctly from the other fjords by constantly showing a very slow growth-rate of its plaice stock. The only counterpart to these low increments, to be found in other fjords, was observed in the outer parts of Gullmar Fjord on the "threshold", where in the shallow waters (5 to 9 m.) the growth-rate in June 1923 was found to correspond fairly well with that seen in Stig Fjord. Even in the deeper waters of this district the plaice were fairly small (Table 13, March 1930). Strongly opposed to these low yearly increments are the rapid growth-rates found in the inner Gullmar Fjord (Färlef Fjord) and in Bro Fjord. Åby and Ellös Fjords come nearer to the latter in respect to size and growth-rate of the plaice, without attaining, however, quite as high mean values for growth.

The cause of these variations may not be the same in all cases and is frequently difficult to ascertain. That the variations are due, to some extent, to the varying density of the stock, is evident. Thus, for instance, the Åby Fjord plaice stock showed in July 1929 considerably greater average increments than those of March 1923, when the stock was far more abundant, the stock being for several of the intervening years very poor. The conditions in Stig Fjord, however, call for a different explanation. In spite of the

Table 13. The Average Length of the Plaice per Year-class in the Different Fjords.

Fjords	Date	Depth in m.	Lengths of Plaice in centimetres. Groups											
			I		II		III		IV		V		VI	
			♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
Åby Fjord	March 1923	20	..	..	..	..	27.5	26.8	31.3	32.3	31.6	35.0	26.0	33.0
							(2)	(5)	(33)	(39)	(3)	(1)	(1)	(1)
—	July 1929	20	..	..	26.5	25.1	33.7	34.5	36.0	39.3	39.0	..	..	..
					(4)	(7)	(4)	(8)	(2)	(3)	(1)			
Bro Fjord	Octbr. 1922	28-35	..	..	28.6	22.3	33.0	33.7	33.7	34.5	35.0	38.0	34.0	..
					(3)	(3)	(23)	(37)	(13)	(13)	(1)	(3)	(1)	
—	March 1926	29	..	..	..	..	28.3	..	32.5	33.2	40.0	39.5	..	..
							(3)		(8)	(8)	(1)	(6)		
—	March 1930	28-35	..	..	..	..	30.3	29.0	34.5	34.6	..	34.4	..	..
							(3)	(3)	(4)	(6)		(5)		
GullmarFjord (Färlef Fd.)	Oktbr. 1922	30-35	..	..	..	29.0	33.2	34.7	35.2	36.2	34.3	37.6	..	36.0
						(1)	(20)	(22)	(7)	(17)	(3)	(3)		(1)
GullmarFjord (Threshold)	June 1923	5-9	..	..	..	21.0	24.5	22.6	25.7	25.8	27.0	24.0	..	..
						(1)	(2)	(3)	(7)	(13)	(3)	(1)		
GullmarFjord (Threshold)	March 1930	25-50	..	..	..	25.0	27.7	27.5	30.1	31.6	..	..	..	..
						(1)	(17)	(19)	(8)	(15)				
Ellös Fjord	Octbr. 1922	10-20	..	..	..	25.3	31.8	31.9	34.0	34.3	..	..	..	..
						(6)	(29)	(54)	(1)	(3)				
Stig Fjord	Octbr. 1922	12-16	16.1	16.9	23.1	24.6	25.4	25.0	..	..	..	..	..	..
			(26)	(34)	(28)	(4)	(5)	(5)						
—	Decbr. 1924	7-16	..	..	..	..	23.9	25.9	27.4	29.7	..	..	..	..
							(14)	(21)	(9)	(20)				
—	Septbr. 1926	9-25	..	17.6	23.8	22.5	24.5	24.5	26.5	26.5	..	..	..	..
				(5)	(15)	(31)	(4)	(4)	(2)	(2)				
—	Septbr. 1927	7-24	..	..	23.6	23.9	28.5	24.0	..	..	..	..	..	..
					(24)	(32)	(2)	(1)						
—	August 1929	9-21	17.2	15.7	20.2	19.9	21.0	23.0	..	..	..	..	..	..
			(7)	(17)	(19)	(31)	(1)	(1)						

(The figures in brackets denote the number of individuals examined.)

fact that the stock in Stig Fjord was much poorer in 1926 to 1927 than in 1922 to 1924, no marked alteration in the growth-rate could be established during the first-mentioned period. The plaice were equally poor in growth during the entire period. The thinning of the stock did not have the same effect as usual, and we may probably look for an explanation of these facts in the hydrographical conditions under which the plaice live in Stig Fjord. On comparing further, as I have done in Fig. 10, the mean size of the plaice from a number of fjords, a marked distinction between the plaice living in the shallow waters of Stig Fjord and those of the other fjords, which were taken in deeper waters, will be evident. I shall later return to the conditions on the "threshold", at

the entrance to Gullmar Fjord. The hydrographical conditions, particularly the salinity, differ greatly in the shallows as compared with the deeper waters where plaice were caught, such as for instance those of Färlef Fjord and Bro Fjord. The low and possibly

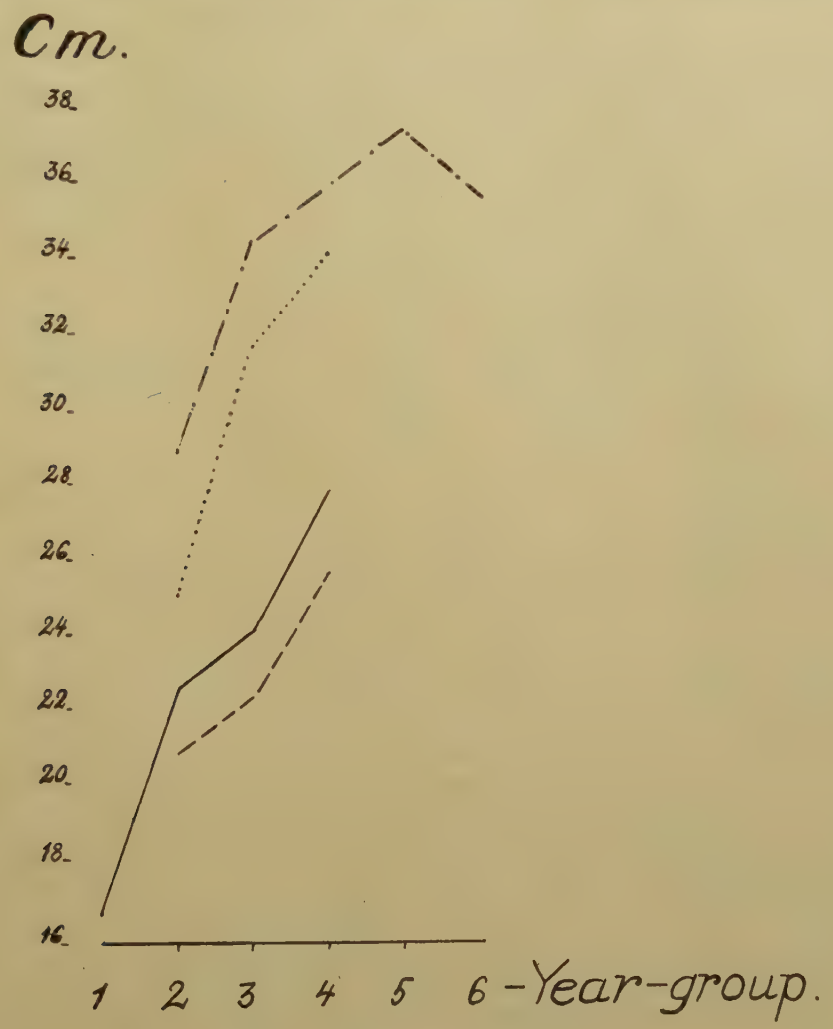

Fig. 10. Average Length of Plaice (females) from:
———— Stig Fjord, depth 7—16 m.
— — — — Gullmar Fjord, Threshold, depth 5—9 m.
—·—·— — — , Färlef Fjord, depth 30—35 m.
····· Ellös Fjord, depth 10—20 m.

very varying salinities may probably have exerted an inhibitory influence upon the growth-rate of the plaice in Stig Fjord (Table 14).

According to the results of some still unpublished investigations undertaken by

Table 14. Salinity and Temperature of the Bottom Water at certain Stations in Gullmar Fjord and Stig Fjord in Areas where Plaice were chiefly caught.

Locality	Station	Date	Depth in m.	Salinity in ‰	Temperature	Remarks
Gullmar Fjord (Threshold)	G. 33 B.	21/9 1923	8—9	26.04	13.12	Cp. Molander 1928. Locality for the capture of plaice from the threshold June 1923 (Table 13).
	G. 42 C.	21/9 1923	5	22.84	13.03	
Gullmar Fjord (Färlef Fjord)	G. 58	22/9 1923	35	31.51	12.15	Locality for the capture of plaice from Färlef Fjord.
	G. 58	11/11 1924	35	33.59	11.00	
Stig Fjord	S. 2	27/9 1923	24	26.44	13.00	The main locality for the more abundant distribution of plaice in Stig Fjord.
—	S. 2	1/12 1924	24	31.59	10.30	
—	S. 9	27/9 1923	7	23.19	11.98	
—	S. 9	3/12 1924	7	21.78	5.10	
—	S. 30	27/9 1923	10	24.31	12.50	
—	S. 30	2/12 1924	10	22.23	5.90	
—	S. 31	24/9 1923	8	23.98	12.60	
—	S. 31	2/12 1924	9	21.87	5.72	

myself concerning the animal communities living in Stig Fjord, there is, quantitatively such a rich bottom fauna in the parts of the fjord where the plaice are most abundant that it seems little probable that the competition for food should have given rise to the slow growth-rate of the plaice, even disregarding the fact that, if such were the case, an alteration should have occurred on account of the marked thinning of the stock during the years 1926 to 1927. The "milieu" created by the hydrographical conditions in Stig Fjord must therefore be held mainly responsible for the slow growth-rate of the plaice in this locality. Further, it may be observed, according to Table 13, that as regards mean size of the plaice a comparison between Group II of the Stig Fjord stock and the same group of other fjords shows less difference than does a comparison between the older groups. For, during the first two years of life the plaice in the fjords usually live in the shallow areas (up to 5—6 m. depth). During this period the growth-rate is everywhere slow. When the fish go to live in deeper waters, the growth-rate will always increase. That the hydrographical conditions in Stig Fjord, where the water is on the whole rather shallow, are less favourable to the plaice, might also be indicated by the fact that the plaice usually emigrate from this fjord one year earlier than they do from the other deeper fjords.

An example taken from the threshold at the entrance to Gullmar Fjord may probably also support the supposition I made in the preceding pages as regards the effect exerted upon the growth-rate by hydrographical factors. Thus, for instance, in 1923 (Table 13) plaice which were caught here at a depth of 5 to 9 m. showed a very small increment of growth. Table 14 shows, moreover, that the salinity in these parts is low. Even the older individuals, which had remained at this low depth, were thus markedly checked in growth. We have here a parallel to the conditions in Stig Fjord.

Although we should here, perhaps, to a greater extent pay attention also to the food conditions. Particularly for the somewhat older plaice — Groups I and II — which frequent the shallow banks of Gullmar Fjord, the food conditions may probably be less favourable. It appears from my previous investigations of the bottom fauna in this Fjord (Molander 1928), that the sand bottom in these shallow localities, where for instance the plaice from the threshold were caught in June 1923, showed very low values for food quantity per square metre. As a very abundant stock of young plaice periodically occur in these parts, resulting in a great competition for food, this might contribute to the slow growth-rate of the plaice established within this area.

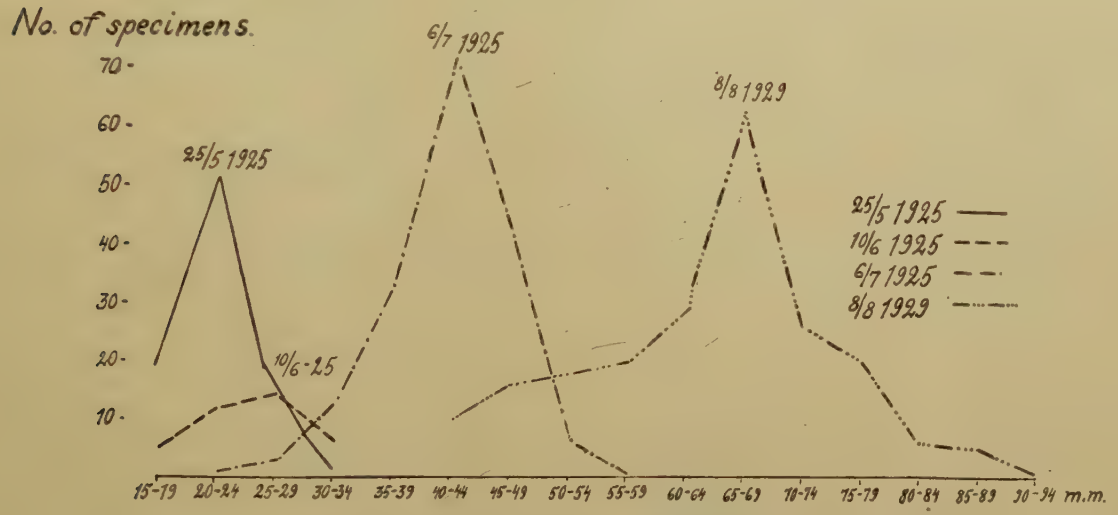

Fig. 11. Length of 0-group in Gullmar Fjord.

Another example will illustrate how the growth-rate within the fjords may vary. Even in the deeper parts of the entrance to Gullmar Fjord (30 to 50 m.), where the food conditions seem to be very favourable, we find a lower average growth-rate for the plaice than in Färlef Fjord, where the rate, as shown in the table, is very high. This might be due to the periodical occurrence of very large stocks, as also to a pronounced admixture, during the first years of life, of very slow-growing individuals from the adjacent shoals.

Thus, these several examples seem to confirm the supposition that different factors play a rôle as regards the growth rate of the plaice in the fjords. It is of considerable interest that the hydrographical conditions exert so marked an influence upon the rate of growth. Stig Fjord affords the most typical example of this. From this point of view it would seem of a certain interest to subject the size of the 0-group of plaice to a closer study (Table 15). These plaice, for instance, do not show any lower increment values in the Stig Fjord than in other fjords. The more uniform hydrographical conditions, which always exist in shallow waters, might explain this phenomenon, as was

already pointed out when we were concerned with the I- and II-groups of plaice that had remained in the shallow waters. The growth-rate of the 0-group in the fjords usually seems to be quite favourable (Tables 15 and Fig. 11).

Table 15. Analysis of Length of Plaice belonging to the 0-group from different Fjords in Bohuslän.

(The figures in brackets denote percentages.)

Fjords	Date	Length in millimetres												Total
		35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	
Åby Fjord	Aug. 1929	..	3	3	8	7	21	10	14	3	2	..	..	71
			(4.2)	(4.2)	(11.2)	(9.8)	(29.5)	(14.1)	(19.7)	(4.2)	(2.8)			
Bro Fjord	—	..	4	5	8	28	29	13	5	4	1	2	..	99
			(4.0)	(5.1)	(8.1)	(28.2)	(29.2)	(13.1)	(5.1)	(4.0)	(1.0)	(2.0)		
Gullmar Fd.	—	..	10	16	18	20	28	63	26	20	6	5	1	213
			(4.6)	(7.5)	(8.5)	(9.4)	(13.1)	(29.6)	(13.1)	(9.4)	(2.8)	(2.3)	(0.5)	
Ellö Fjord	—	1	9	20	20	30	20	16	17	13	10	..	..	156
		(0.6)	(5.7)	(12.8)	(12.8)	(19.2)	(12.8)	(10.2)	(10.8)	(8.3)	(6.4)			
Stig Fjord	—	..	..	1	..	1	3	2	2	..	4	..	..	13
				(7.6)		(7.6)	(22.8)	(15.2)	(15.2)		(30.4)			

Mean capture per 30-minutes' haul:

Åby Fjord	17	individuals
Bro Fjord	15	—
Gullmar Fjord	75	—
Ellö Fjord	149	—
Stig Fjord	24	—

7. Fishery Experiments for the 0- and I-Groups of Plaice off the Halland Coast.

During August 1929, as mentioned in the introductory remarks of this report, trawling experiments were also made off the Halland coast for younger year-classes of plaice. The results are shown in Table 16 and in Chart III.

Table 16. Survey of the Catches of Plaice belonging to groups 0- and I in August 1929 off the Halland Coast per 30-minutes' Haul.

Locality	Station	Depth in m.	0-group	I-group
Vendelsö Fjord	Lurendal Bay	1/2—1	7	11
	Näs Bay	1/2—1 1/2	23	11
	Lanna Bay	1/2—1	58	39

Table 16 (continued).

Locality	Station	Depth in m.	0-group	I-group
Varberg	Little Apelvik	2—4	1	1
	Great Apelvik	½—2	4	1
	Getterön	½—1	24	6
Falkenberg	North of the Harbour	1—3	0	0
	South of the Harbour	1—3	0	3
Isle of Tyl	Haferdal Bay	½	7	2
	Tylösand	½—4	9	1
	Frösakull	½—1	6	4
Halmstad	Påarp	1—2	8	57
	Örnäsvik	1—3	2	7
	The Beach	1½—3	2	3
Laholm Roads	North of the river mouth	1½—2	0	9
	South of the river mouth	2	0	0
Båstad	The Roads	1—3	2	5
	North of Skummeslöv	2	2	18
	Skummeslöv	2	6	34
Toreskov	North of Toreskov	3	0	0
	The Roads	1—4	18	37

8. Summary.

The Swedish investigations of plaice off the West Coast of Sweden showed that there is an abundant stock of plaice in the Bohuslän Fjords. It seems to be mainly in the outer fjords — for instance Björkö, Stig, Ellös, Gullmar, Bro and Åby Fjords — (Chart I) — that the plaice occur in large numbers, whilst the inner fjords as a rule have very poor stocks. In respect of topography the above-mentioned fjords differ very much, as do also the food conditions for plaice, but the plaice seem always to have adapted themselves to the bottom fauna and the associations which characterize the different fjords.

The fjord stocks — particularly those of Stig Fjord, the entrance to Gullmar Fjord, Ellös and Björkö Fjords — have been very abundant periodically, but, like the stock outside the Skärgård, they undergo marked fluctuations. These were apparently connected with the occurrence of strong and weak broods. The very conspicuous increases in the plaice stocks of the fjords, which were noted for instance between 1921 and 1924, were chiefly due to the appearance of the 1919 year-class, and, as regards Stig Fjords, the 1920 and 1921 classes also seem to have played a great rôle. On the whole, the fjord

stocks prove to have afforded an index to the stock outside the Skärgård, even though a certain year-class may not be equally dominant in all the fjords. The latter phenomenon, in its turn, may be attributable to certain irregularities in the immigrations into the fjords of the youngest stages of plaice. The fluctuations in the abundance of the different year-classes are, as far as the fjords are concerned, strongly manifest in that a regular emigration occurs when the plaice have reached a definite age and size. For this reason, a fjord may be almost entirely depleted of its stock of plaice after the emigration of a very strong brood.

Spawning of the plaice does not take place within the fjord district. The scanty mature females, as well as the few, for the most part unfertilized eggs, which were found at some of the fjord entrances have no significance, in this connection, for the recruiting of the stocks. The young bottom stages of plaice, which already in the spring and early summer occurred in the outer parts of the fjords, had immigrated from the sea and open coastal waters. As a rule, the plaice remain in the fjords for about three to four years, individuals older than Group IV having been found only in the deeper fjords — by far the greater majority of which were females (about 70 to 80 per cent.). The youngest broods — Groups 0 and I — frequent the shallow shore districts of the fjords, whilst the older broods — Groups II to VI — live in deeper waters. The life conditions for the development of the plaice seem, on the whole, to be favourable in the fjords, a rapid growth-rate being substantiated in most of the fjords and the plaice which leave the fjords being also usually large individuals. The Stig Fjord stock of plaice, however, shows a slow rate of growth, which, in all probability, is due to unfavourable hydrographical factors, chiefly the salinity, which is on the whole low in this locality. Generally, the greater or lesser density of the stocks should give rise to variations in the growth-rate. The plaice which leave the fjords at the period when maturity is approaching, vary somewhat in size. In Stig Fjord, where the growth-rate is slower than in the other fjords, the plaice emigrate when they are rather small, usually after their third year of life. The emigrating plaice go first to the coastal waters of Sweden, but they migrate also, to a great extent, away from the Swedish coast; thus, according to the marking experiments undertaken, nearly half of the emigrating plaice had gone to other districts. A number of these (about 25 per cent.) had gone as far as the Danish coastal waters at the Skaw district; 15 per cent. had migrated into the North Sea and were recaptured for the most part within important spawning grounds.

The spawning grounds off the Swedish coast do not seem to be very extensive or important. Only a scanty number of plaice eggs were found in these parts. It is therefore probable that larvae from other spawning grounds are carried towards the Swedish coast, invading the Bohuslän Fjords as larvae or, for the most part perhaps, as young bottom stages, more or less numerous. The Skaw district is here chiefly concerned, and the south and eastward bound currents prevailing in the Kattegat and adjacent parts of the Skagerak play no doubt an important rôle in the recruiting of the fjord stocks. The irregularities in the immigrations, which have been established, may be attributed to the alterations which take place in the direction and strength of certain currents.

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Die deutsche Fischerei im Kattegat mit besonderer Berücksichtigung der Schollenfischerei.

Von

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A. Die Fahrzeuge.

Von Deutschland wurde bisher im Kattegatt fast ausschliesslich nur mit Dampfern gefischt, die den Fang an die grossen Fischmärkte der Nordsee bringen. Es erscheint verwunderlich, dass die an der Küste Schleswig-Holsteins, Lübecks und Mecklenburgs beheimateten Scheernetzkutter mit der fortschreitenden Verarmung der westlichen Ostsee nicht auch Fangreisen in das Kattegatt gemacht haben, da sie doch die westliche Ostsee verlassen und die zum Teil weiter entfernten Fischgründe der mittleren Ostsee aufsuchen, wo sie von Stützpunkten an der deutschen Küste oder von Bornholm aus ihre Fischerei betreiben. Sie müssen dabei eine wochenlange Trennung von ihrer Familie in Kauf nehmen, während sie nach jeder Fangreise in das Kattegat wieder zu ihrem Heimathafen zurückkehren könnten. Neben der Unkenntnis der lohnenden Fanggründe im Kattegatt dürfte für die Ostseekutter mit dem beschränkten Fassungsvermögen ihrer Bünn die wahrscheinliche Unwirtschaftlichkeit der Fangreisen in das Kattegatt die Ursache sein, dass dieses Gebiet von ihnen nicht befischt wird. Denn es erscheint fraglich, ob selbst bei gutem Fangergebnis die Unkosten für die je ca. 180 Sm lange Dampfstrecke der Hin- und Rückfahrt im Verhältnis zum Gesamterlös noch tragbar sind.

Auch die grösseren Nordseekutter mit Bünn besuchen das Kattegatt nicht. Bei ihren stärkeren Motoren und ihrem grossen Fischraum könnte die Fangreise trotz der Länge der Dampfstrecken noch gewinnbringend sein. Aber sie sind darauf eingestellt, die hoch bezahlten lebenden Fische an den Markt zu bringen und das ist ihnen bei einem Transport ihres Fanges durch den streckenweis Süsswasser führenden Kaiser-Wilhelm-Kanal nicht möglich. Einige neue Nordseekutter sind allerdings ohne Bünn gebaut. Sie haben einen gegen Wärmeverlust isolierten Fischraum, führen Eis an Bord und bringen die Fische an wie die Fischdampfer. Ihnen ist die Befischung des Kattegatts möglich. Sie ist auch im Winter 1929—30, veranlasst durch das Ausbleiben der Herings- und Sprottschwärme in der Deutschen Bucht der Nordsee, von einem Kutter — angeblich mit Erfolg — versucht worden.

B. Die deutsche Fischerei.

Die deutschen Fischdampfer befischen das Kattegatt nicht während des ganzen Jahres sondern nur vom Herbst bis ins Frühjahr. Es hat das wohl darin seine Ursache, dass meist nur die älteren, kleineren Dampfer unserer Hochseeflotte das Gebiet aufsuchen, das in der rauheren Jahreszeit mehr Schutz und dadurch grössere Ausnutzungsmöglichkeit der Reisezeit bietet als die Nordsee. Einen besonderen Anreiz zur Befischung des Kattegatts bietet der Fang von im Preis hochstehenden Fischen wie Seezunge, Steinbutt, Tarbutt, echte Rotzunge, Scholle und Schellfisch, die im Gesamtfang zwar mengenmässig zurücktreten, in Bezug auf den Werterlös die Rentabilität der Kattegattreisen aber günstig beeinflussen. Während der Sommermonate befischen diese Dampfer die reicheren Fischgründe der Nordsee.

Die deutsche Kattegatt-Fischerei setzt meist erst Ende September mit wenig Dampfern ein, wächst mit Eintritt des Winters und hört im März oder April, ausnahmsweise auch erst Anfang Mai, auf. In welchen Monaten in den einzelnen Jahren von 1924 bis 1930 das Kattegatt durch deutsche Dampfer befischt worden ist, mit welcher Intensität und welche Fangmengen erzielt worden sind, zeigt die folgende Übersicht:

Tabelle I.

Monat	1924		1925		1926		1927		1928		1929		1930	
	Reisen	Fangmenge kg	Reisen	Fangmenge kg	Reisen	Fangmenge kg	Reisen	Fangmenge kg	Reisen	Fangmenge kg	Reisen	Fangmenge kg	Reisen	Fangmenge kg
Januar	24	421004	78	820113	35	563319	42	708230	27	504385	40	626572	40	545152
Februar	30	480926	59	823442	42	769752	36	527754	45	824308	8	157615	24	404573
März ..	33	638999	21	270559	55	904842	12	187484	20	286509	2	45617	5	78197
April ..	28	402266	3	47536	5	74977	—	—	1	5443	—	—	1	11710
Mai ...	5	87317	1	14986	—	—	—	—	—	—	—	—	—	—
Juni...	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Juli ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—
August	—	—	—	—	—	—	—	—	—	—	1	32490	1	27809
Septbr.	3	36559	4	90383	1	27388	—	—	1	27062	1	27055	1	18633
Oktbr..	10	116690	8	127986	6	80470	3	38121	2	34942	—	—	3	37803[1])
Novbr.	33	409157	27	360299	14	150607	5	69139	2	14960	2	33944	4	44269
Dezbr..	60	631628	21	304358	35	441403	13	189241	15	158577	15	160092	11	156469
Sa.....	226	3224546	222	2859662	193	3012758	111	1719969	113	1856186	69	1083385	90	1324615

Betrachtet man die Zahlen für die einzelnen Monate, so zeigt sich, dass die Hauptfischerei in allen Jahren in den Monaten Januar, Februar, März und Dezember stattfand. Die Berechnung ergibt, dass in den genannten Monaten der Jahre 1924 bis 1929 ca. 82 %

[1]) Die Zahlen für die Monate Oktober bis Dezember 1930 wurden während des Druckes in die Tabellen I, VI und VII eingefügt.

aller Reisen ausgeführt wurde, und dass ca. 50 % aller Reisen allein auf die Monate Januar und Februar entfallen.

Auffallend ist ferner, dass die Gesamtanzahl der Reisen sich vom Jahre 1924 ab ständig verringert hat. Die Zahl ist von 226 Reisen im Jahre 1924 auf 69 Reisen im Jahre 1929 zurückgegangen. Dabei ist allerdings zu bemerken, dass die auffallend niedrige Zahl des Jahres 1929 ihre Ursache darin hat, dass die Eisverhältnisse des strengen Winters 1928—29 im Monat Februar die Fahrten in das Kattegatt stark eingeschränkt haben, daher wird sich für das Jahr 1930 wieder ein Anstieg ergeben, denn bis September 1930 haben bereits 72 Reisen stattgefunden. Die Gesamtzahl für 1930 wird aber die Zahl des Jahres 1928 voraussichtlich nicht erreichen, wenn man die Reisen der noch fehlenden Monate nach denen der Vorjahre schätzt.[1])

Für die Beurteilung ist es wohl richtiger, wenn man die Anzahl der Reisen nicht nur nach dem Kalenderjahr aufführt, sondern nach der Fangsaison, also vom Herbst eines Jahres bis Frühjahr des nächsten Jahres. Dann ergeben sich folgende, das Gesagte bestätigende Zahlen:

Fangsaison	1924—25	1925—26	1926—27	1927—28	1928—29 (Eiswinter)	1929—30
Reisen	268	197	146	114	70	89

Der deutliche Rückgang ist keine zufällige Erscheinung, sondern hängt mit der schon oben erwähnten Tatsache zusammen, dass meist nur die kleineren Dampfer zur Kattegattfischerei verwendet werden. Es besteht aber in der deutschen Hochseefischerei, wie auch in anderen Ländern, die Tendenz, immer grössere Dampfer mit stärkerer Maschinenkraft zu bauen, die zur Befischung der weit entfernt liegenden Fanggründe geeignet sind, oder die auch noch bei stürmischem Wetter den Fischereibetrieb auf der Nordsee durchhalten können. Die älteren kleineren Dampfer werden mehr und mehr ausser Dienst gestellt und durch grössere Dampfer ersetzt, für die die Fischerei im Kattegatt nicht lohnend genug ist. Dass es nicht der zu geringe Fang ist, der den Rückgang der deutschen Fangreisen im Kattegatt verursacht hat, zeigt die Tabelle II.

Tabelle II.

Es fanden statt:

1924...	226	Reisen	mit	2989	Reisetagen	=	im	Durchschnitt	13,2	Reisetage	mit	je	1079	kg	Fang
1925...	222	—	-	2902	—	=	-	—	13,1	—	-	-	986	-	—
1926...	193	—	-	2452	—	=	-	—	12,7	—	-	-	1229	-	—
1927...	111	—	-	1419	—	=	-	—	12,8	—	-	-	1212	-	—
1928...	113	—	-	1422	—	=	-	—	12,6	—	-	-	1306	-	—
1929...	69	—	-	901	—	=	-	—	13,1	—	-	-	1203	-	—

Wie aus der rechten Hälfte der Tabelle zu ersehen ist, ist die Durchschnittzahl der Reisetage annähernd die gleiche geblieben. Sie schwankt zwischen 12,6 und 13,2 Reisetagen. Auch die durchschnittliche Fangmenge je Reisetag zeigt in den verschiedenen Jahren nur Schwankungen in geringen Grenzen (mit Ausnahme des Jahres 1925). Sie ist überdies in den späteren Jahren höher als 1924 und 1925, wodurch doch eigentlich

[1]) Sie betrug 90 Reisen (Anmerkung während des Druckes).

ein Anreiz zur intensiveren Befischung des Gebiets gegeben gewesen wäre. Im Vergleich mit dem Durchschnittsfang je Reisetag der gesamten deutschen Dampferfischerei mit dem gewöhnlichen Grundschleppnetz (also die Heringstrawl-Fänge nicht eingeschlossen) ist der durchschnittliche Kattegattfang gering, nähert sich jedoch dem Durchschnittsfang der Nordseefischerei, wie die folgende Gegenüberstellung zeigt.

	1926	1927	1928	1929
Gesamtfang pro Reisetag.....	1980 kg	2097 kg	2082 kg	2208 kg
Kattegattfang — —	1229 -	1212 -	1306 -	1203 -
Nordseefang — —	1294 -	1372 -	1314 -	1413 -

Einen weiteren Hinweis auf den allmählichen Rückgang der Befischung des Kattegatt durch deutsche Dampfer geben die Prozentzahlen der Kattegattreisen von der Gesamtzahl aller deutschen Fischdampferreisen. Es fanden statt:

Im Jahre.....	1924	1925	1926	1927	1928	1929
Fischdampferreisen	5164	5374	5227	5293	4947	4893
Davon ins Kattegatt	4,38 %	4,13 %	3,69 %	2,10 %	2,28 %	1,41 %

Die wichtigsten Fische der deutschen Fischerei im Kattegatt sind sowohl der Menge wie dem Wert nach die Gadiden: Kabeljau (*Gadus morrhua*), Wittling (*Gadus merlangus*), Pollack sowie Seelachs (*Gadus pollachius* und *G. virens*) und Schellfisch (*Gadus aeglefinus*). Dann folgen die Plattfische: Scholle (*Pleur. platessa*), Steinbutt (*Rhombus maximus*), Glattbutt (*Rhombus laevis*), echte Rotzunge (*Pleur. microcephalus*), Seezunge (*Solea vulgaris*) und schliesslich: Knurrhahn (*Trigla gurnardus*), Petermann (*Trachinus draco*) und Katfisch (*Anarrhichas lupus*). Die absoluten Zahlen der Fangmenge gibt die folgende Tabelle.

Tabelle III. Anlandungen in kg durch Fischdampfer.

Jahr	Kabeljau	Wittling	Pollack u. Seelachs	Schellfisch	Scholle	Seezunge	Steinbutt	Tarbutt	Echte Rotzunge	Knurrhahn	Petermann, echter	Katfisch	Übrige Fische	Zusammen
1924	1308554	538736	213767	324614	94358	13949	26152	46899	1918	73436	314468	53114	214580	3224545
1925	1271658	604164	138454	324802	80273	14929	13885	22073	4405	48997	108748	37848	189425	2859661
1926	1502085	449893	184019	322174	66312	7086	21619	38568	4996	98456	171328	46742	99480	3012758
1927	951357	256290	88001	114909	53404	4476	9950	20976	6919	61836	63056	38618	50177	1719969
1928	1129574	252050	135524	68180	64137	8953	11342	21246	6901	21006	45138	27168	64967	1856186
1929	479081	189776	127196	67053	30762	10752	10815	20144	5637	47224	37169	14512	43264	1083385

Diese absoluten Zahlen geben aber bei der durch die Verringerung der Fangreisen bedingten Verkleinerung der Fänge kein klares Bild über die Bedeutung der einzelnen Fischarten für die Zusammensetzung der Fänge in den einzelnen Jahren. Es sei daher in der folgenden Tabelle der prozentuale Anteil gegeben, den jede der genannten Fischarten in den Jahren 1924—29 am Gesamtfang der Menge nach gehabt hat.

Tabelle IV. Prozentzahlen vom Gesamtfang nach Gewicht.

	1924 %	1925 %	1926 %	1927 %	1928 %	1929 %
Kabeljau	40,58	44,47	49,86	55,31	60,85	44,22
Wittling	16,71	21,13	14,93	14,90	13,68	17,55
Pollack und Seelachs	6,63	4,84	6,10	5,12	7,20	11,75
Schellfisch	10,07	11,36	10,69	6,68	3,70	6,20
Scholle	2,93	2,81	2,20	3,10	3,46	2,84
Seezunge	0,43	0,52	0,24	0,26	0,48	0,99
Steinbutt	0,81	0,49	0,72	0,58	0,61	1,00
Tarbutt	1,45	0,77	1,28	1,22	1,14	1,86
Echte Rotzunge	0,06	0,15	0,17	0,40	0,37	0,52
Knurrhahn	2,28	1,71	3,27	3,60	1,13	4,36
Petermann	9,75	3,80	5,69	3,67	2,43	3,43
Katfisch	1,65	1,32	1,55	2,25	1,46	1,34

Die Tabelle zeigt, dass für die deutsche Kattegatt-Fischerei der Kabeljau der bei weitem wichtigste Fisch ist, der alljährlich fast 50 % oder darüber vom Gesamtfang ausmacht. In weitem Abstand folgt der Wittling und die anderen Gadiden. Die oben genannten Plattfische betragen zusammen der Menge nach alljährlich nur ca. 5 bis 6 % vom Gesamtfange. Anders ist es aber, wenn man auf den Wert eingeht. Leider stehen für die Werte nur Angaben aus den Jahren 1928 und 29 zur Verfügung. Die Berechnung ergibt, dass im Jahre 1928 23,54 % und 1929 sogar 30,61 % des Gesamterlöses auf die genannten Plattfische entfallen.

In einzelnen sind die Prozentzahlen der Werte die folgenden.

Tabelle V. Prozentzahlen vom Gesamterlös.

	1928		1929	
Kabeljau	42,43 %		25,40 %	
Wittling	10,08 -		12,47 -	
Pollack und Seelachs	8,61 -		10,38 -	
Schellfisch	6,76 -		9,46 -	
Scholle	7,75 -		6,45 -	
Seezunge	4,32 -		9,45 -	
Steinbutt	4,57 -	23,54 %	5,88 -	30,61 %
Tarbutt	5,13 -		6,94 -	
Echte Rotzunge	1,77 -		1,89 -	
Knurrhahn	1,01 -		2,63 -	
Petermann	2,71 -		3,99 -	
Katfisch	1,27 -		1,02 -	

Aus der Tabelle ist auch zu ersehen, welche Bedeutung im einzelnen die Plattfische, namentlich Seezunge und Scholle, dem Wert nach für die deutsche Kattegattfischerei haben.

C. Die deutsche Schollenfischerei im Kattegatt.

Aus Tabelle VI, unten, ist der deutsche Kattegattfang an Schollen und dessen Verhältnis zum deutschen Gesamtfang im Kattegatt zu ersehen. — Der Fang ist in den einzelnen Monaten nicht der gleiche. Die besten Erträge an Schollen fallen in die Zeit von Ende November bis Anfang März und insbesondere sind Dezember und Januar die besten Fangmonate. Das zeigen die Tabellen VI und VII, von denen die erstere die absoluten Mengen in den einzelnen Monaten der verschiedenen Jahre gibt, während in Tabelle VII (um einheitliche und vergleichbare Zahlen zu erhalten) die Menge der Schollen pro Reise berechnet ist. Aus ihr ergibt sich das Gesagte mit grösster Deutlichkeit, namentlich aus der letzten Spalte, in der die Durchschnittsfänge für die einzelnen Monate pro Reise errechnet sind. Es scheint demnach, als ob die Schollen sich in den Monaten November bis Februar auf den Gebieten sammeln, die vorwiegend von den Dampfern befischt werden, in den Herbstmonaten dorthin wandern und in den Frühjahrsmonaten von dort wieder abwandern.

Tabelle VI. Fang an Schollen in den einzelnen Monaten in kg.

	1924	1925	1926	1927	1928	1929	1930
Januar	15568	34969	16254	26355	26236	22145	23309
Februar	14099	19290	16801	14269	22723	3333	9704
März	10159	3409	11496	2875	8074	788	840
April	3937	850	592	—	72	—	95
Mai	614	108	—	—	—	—	—
August	—	—	—	—	—	75	87
September	520	493	140	—	147	100	26
Oktober	2210	1027	1061	282	428	—	280
November	12027	7464	3797	1075	145	535	2172
Dezember	35224	12663	16171	8548	6312	3786	3974
Sa.	94358	80273	66312	53404	64137	30762	40487
% vom deutschen Gesamtfang	2,93	2,81	2,20	3,10	3,46	2,84	3,08

Aus den in Tabelle VII unten gegebenen Zahlen ergibt sich, dass die deutsche Fischerei über einen Rückgang der Schollenfischerei im Kattegatt nicht zu klagen hat. Im Gegenteil sind die Jahre 1928 mit 568 kg und 1929 mit 446 kg Jahresdurchschnittsfang pro Reise erheblich besser als die Jahre 1924 bis 1926. In Bezug auf die Stückzahl — ein Hinweis auf den Bestand — ist das Jahr 1928 das weitaus beste gewesen, da damals in den deutschen Fängen die Sorte IV (d. h. die kleinsten und im Gewicht niedrigsten marktfähigen Schollen) im Gesamtfang ganz ausserordentlich hervortrat, wie weiter unten (Kurve Seite 94) gezeigt werden wird.

Zum Vergleich ist in Tab. VIII, S. 92, neben dem Jahresdurchschnitt der Durchschnittsfang an Schollen für die Fangsaison gegeben, also vom Herbst des einen Jahres bis Frühjahr des nächsten Jahres, der für die biologische Auswertung ein besseres Bild geben dürfte.

Tabelle VII. Erträge der Schollenfischerei im Kattegat je Reise in den einzelnen Monaten.

Monat	1924		1925		1926		1927		1928		1929		1930		Im Durchschnitt kg je Reise
	Reisen	Pro Reise kg	Reisen	Pro Reise kg	Reisen	Pro Reise kg	Reisen	Pro Reise kg	Reisen	Pro Reise kg	Reisen	Pro Reise kg	Reisen	Pro Reise kg	
Januar	24	649	78	448	35	464	42	627	27	972	40	553	40	583	576
Februar	30	470	59	327	42	400	36	396	45	505	8	417	24	404	317
März	33	308	21	162	55	209	12	240	20	403	2	394	5	168	249
April	28	190	3	283	5	118	—	—	1	72	—	—	1	95	146
Mai	5	123	1	108	—	—	—	—	—	—	—	—	—	—	120
August	—	—	—	—	—	—	—	—	—	—	1	75	1	88	81
September	3	173	4	123	1	140	—	—	1	147	1	100	1	26	130
Oktober	10	221	8	128	6	177	3	94	2	214	—	—	3	93	165
November	33	364	27	276	14	271	5	215	2	73	2	265	4	563	313
Dezember	60	587	21	603	35	462	13	657	15	421	15	252	11	361	510
Jahres-Durchschnitt	226	418	222	362	193	344	111	481	113	568	69	446	90	449	—

Die nachstehende Übersicht, Tab. VIII, zeigt, dass die oben angegebenen guten Fänge des Jahres 1928 eigentlich auf die Fangsaison 1927—28 kommen, somit besonders in den Monaten Januar und Februar 1928 gemacht worden sind, was auch die Tabelle VII bestätigt. Damals sind also grosse Mengen jüngerer Schollen der Sorte IV (Tiere bis ca. 28—29 cm Gesamtlänge) aufgetreten. Der Rückgang der durchschnittlichen Fangmenge in der Fangsaison 1928—29 wird in der Hauptsache auf die verringerte Befischung im Februar 1929 infolge der Vereisung in dem strengen Winter zurückzuführen sein. Es ergibt sich also auch aus der Gruppierung der Fänge nach der Fangsaison kein deutlicher Hinweis auf eine bedrohliche Verringerung des Bestandes an Schollen auf den von den deutschen Dampfern befischten Gründen.

Tabelle VIII.

Es wurden gefangen in der Fangsaison:

1924—25	108.607 kg	Schollen	in	268	Reisen	=	405 kg	pro	Reisetag
1925—26	66.890 -	—	-	197	—	=	338 -	—	—
1926—27	64.668 -	—	-	146	—	=	443 -	—	—
1927—28	67.010 -	—	-	114	—	=	588 -	—	—
1928—29	23.298 -	—	-	70	—	=	333 -	—	—
1929—30	38.444 -	—	-	89	—	=	430 -	—	—

Es sei nun auf die verschiedenen Qualitäten der Dampferschollen des Kattegatt eingegangen. Seit 1924 besteht an den deutschen Nordseefischmärkten eine einheitliche Sortierung für die verschiedenen Fische. Die Scholle wird in vier Sorten, die nach dem Gewicht unterschieden werden, gehandelt. Die Sortierung geschieht vor der Auk-

tion und es werden die Mengen jeder Sorte und der erzielte Preis in die offizielle Statistik aufgenommen. In der folgenden Übersicht über die vier Sorten ist die ungefähre Grenzgrösse der Tiere in cm (Gesamtlänge) für jede Sorte angegeben, so wie sie sich aus den Marktmessungen ergeben hat.

Tabelle IX. Einheitssortierung an den Deutschen Fischmärkten der Nordsee für Schollen.

Sorte I.	1 kg und mehr	Tiere über ca. 44 cm.
— II.	Von $^1/_2$ bis 1 kg	— von ca. 36—37 bis ca. 43—44 cm.
— III.	— $^1/_4$ - $^1/_2$ -	— — - 28—29 - - 36—37 -
— IV.	Unter $^1/_4$ kg	— — - 23 - - 28—29 -

Die folgende Tabelle zeigt, welche Mengen von jeder einzelnen Sorte in den verschiedenen Jahren gefangen worden sind und es ist dazu errechnet, wieviel % jede Sorte vom Gesamtfang jeden Jahres ausmacht.

Tabelle X.

Es wurden gefangen:

	1924 in 226 Reisen	1925 in 222 Reisen	1926 in 193 Reisen	1927 in 111 Reisen	1928 in 113 Reisen	1929 in 69 Reisen
Schollen I	16257 kg = 17 %	14417 kg = 18 %	12427 kg = 19 %	8369 kg = 16 %	5726 kg = 9 %	4276 kg = 14 %
— II	25396 - = 27 -	19511 - = 24 -	13785 - = 21 -	10909 - = 20 -	8526 - = 13 -	6148 - = 20 -
— III	22038 - = 23 -	30098 - = 38 -	26004 - = 39 -	23589 - = 44 -	21789 - = 34 -	12641 - = 41 -
— IV	30667 - = 33 -	16247 - = 20 -	14096 - = 21 -	10537 - = 20 -	28096 - = 44 -	7697 - = 25 -
Sa....	94358 kg = 100 %	80273 kg = 100 %	66312 kg = 100 %	53404 kg = 100 %	64137 kg = 100 %	30762 kg = 100 %

Zur besseren Übersicht und zur Veranschaulichung sind die Prozentzahlen der vorstehenden Tabelle in der Kurve Fig. 1 dargestellt. Sie zeigt deutlich, dass der wichtigste Teil des deutschen Schollenfanges aus der Sorte III, das sind die Schollen von $^1/_4$ bis $^1/_2$ kg, Grösse von ca. 28—29 bis ca. 36—37 cm, gebildet wird. Nur in den Jahren 1924 und 1928 überwogen die Schollen der Grösse IV, Tiere unter $^1/_4$ kg und von ca. 23 bis 28—29 cm Gesamtlänge.

Ein klareres Bild über die Ausnutzung des Bestandes an Schollen im Kattegatt durch die deutsche Fischerei gibt die Berechnung nach der Einheit des Reisetages, die Tabelle XI enthält (s. S. 94, unten).

Die danach gezeichnete Kurve (Fig. 2) zeigt deutlich, dass der Durchschnittsfang der Sorten I und II in den Jahren 1924 bis 1929 annähernd der gleiche geblieben ist. Die geringen Schwankungen der Sorte I sind von keiner Bedeutung. Sorte II zeigt eine geringe Abnahme im Laufe der Jahre. Bedeutende Abweichungen treten jedoch durch die Kurvenlinien der Sorten III und IV in Erscheinung. Sie sind wohl aus den natürlichen Fluktuationen des Bestandes zu erklären, die sich bei den jüngeren Tieren deutlicher ausprägen als bei den älteren. Leider fehlen Altersbestimmungen an den in Deutschland

angelandeten Kattegattschollen aus den Berichtsjahren völlig. Ohne solche ist man bei der Deutung der Kurven mehr auf Vermutungen angewiesen. Doch scheint das Überwiegen der Sorte IV im Jahre 1924 auf das Auftreten eines guten Jahrgangs hinzudeuten, während das Absinken der Kurve für die jungen Schollen (Sorte IV) in den Jahren 1925, 1926 und 1927 auf drei Jahre schlechten Nachwuchses zurückzuführen

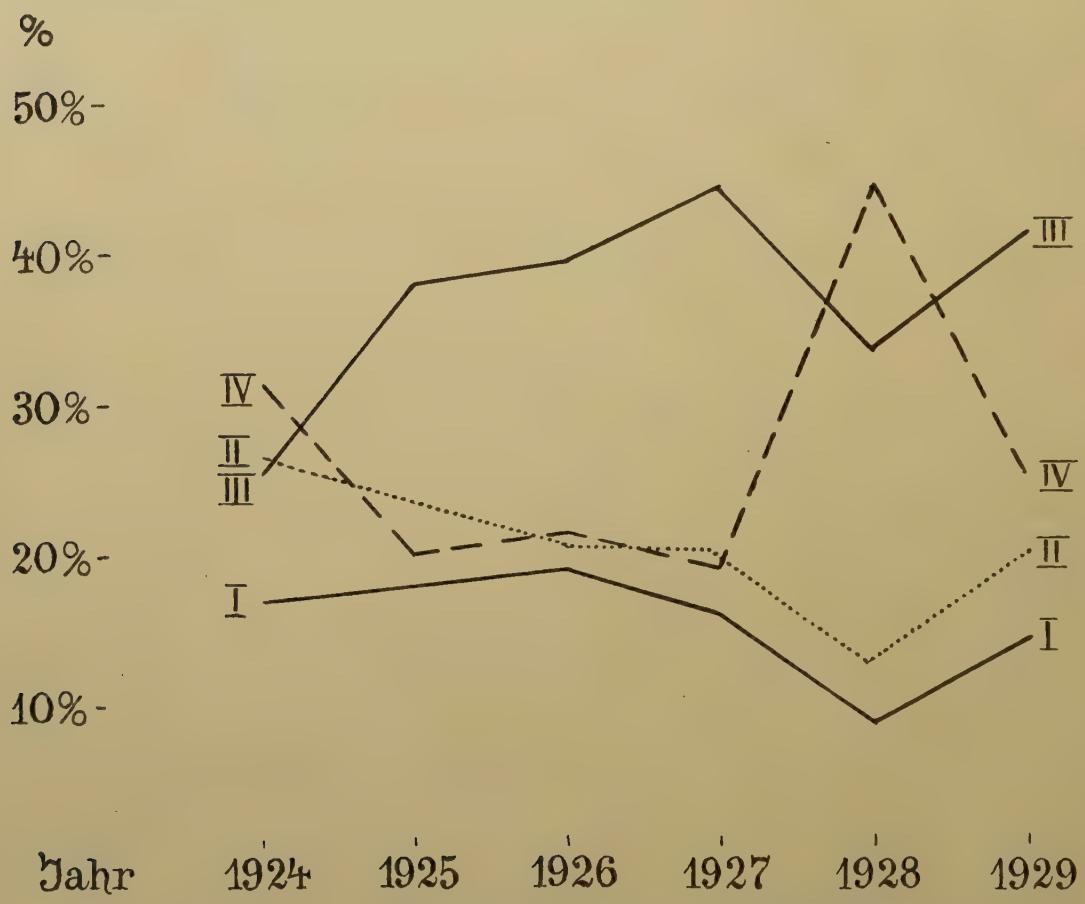

Fig. 1. Der prozentuale Anteil jeder Sorte Schollen am Gesamtfang jedes Jahres.

Tabelle XI. Durchschnittsfänge pro Reise der verschiedenen Sorten Schollen in kg.

Jahr.....	1924	1925	1926	1927	1928	1929
Sorte I.....	72	65	64	75	51	62
— II.....	112	88	71	98	76	89
— III.....	98	136	135	213	193	183
— IV.....	136	73	73	95	249	111

sein dürfte. Der gewaltige Anstieg der Kurvenlinie der Sorte IV für das Jahr 1928 weist aber wohl mit Sicherheit auf das neue Auftreten eines reichen Jahrgangs hin. Schwieriger ist die Beurteilung der Kurvenlinie der Sorte III. Es erscheint gewagt, die gegen 1924

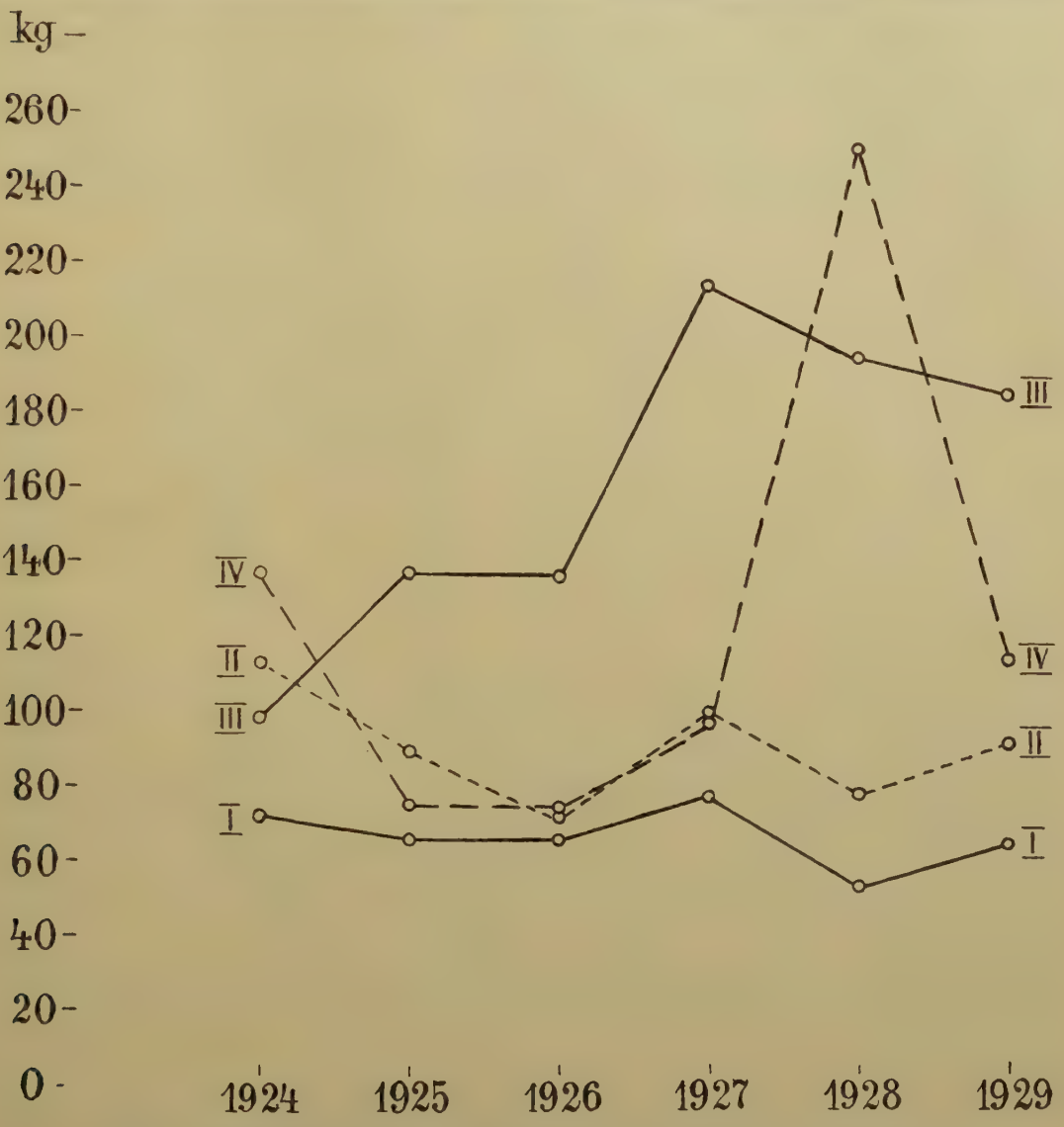

Fig. 2. Durchschnittsfänge der verschiedenen Sorten Schollen pro Reise in kg.

besseren Fänge des Jahres 1925 und der folgenden aus dem guten Vorkommen der Sorte IV des Jahres 1924 abzuleiten. Vielleicht liegen in Dänemark genaue Altersuntersuchungen vor, die eine Erklärung geben können, vielleicht wird es sich aber als zweckmässig erweisen, in Dänemark und Deutschland korrespondierende Untersuchungen

über die Kattegattscholle in Zukunft nach einem noch zu verabredenden Plan vorzunehmen.

Im ganzen betrachtet ist das deutsche Material nur klein und es ist für die Beurteilung der Biologie der Kattegattscholle schon deswegen nicht ausreichend, weil es nur aus einigen Monaten des Jahres stammt. Die Statistik der Internationalen Meeresforschung ermöglicht einen Vergleich der deutschen Schollenfischerei mit dem Gesamtfang an Schollen im Kattegatt. Es ergibt sich daraus, dass Deutschlands Anteil nur wenige Prozent des Gesamtfangs beträgt, und dass, als Folge der allmählichen Einschränkung der deutschen Befischung des Kattegatts diese Prozentzahl im Laufe der Jahre zurückgegangen ist. Das zeigt die folgende Übersicht:

Tabelle XII.

	Gesamtfang an Schollen im Kattegatt kg	Deutscher Fang davon kg	Das sind % vom Gesamtfang
1924.....	1952000	94000	4,8
1925.....	2267000	80000	3,5
1926.....	2308000	66000	2,9
1927.....	3244000	53000	1,6
1928.....	2258000	64000	2,8

Dagegen ist der Umstand zu beachten, dass die deutsche Fischerei im Kattegatt von der dänischen im Fangbetrieb gänzlich verschieden ist. Angeblich sollen auch die von den deutschen Fischdampfern hauptsächlich besuchten Fanggebiete in den Zeiten der deutschen Kattegatt-Fischerei von dänischen Fahrzeugen wenig oder garnicht befischt werden. Vielleicht ist daraus der auffallende Umstand zu erklären, dass, wie oben nachgewiesen, in der deutschen Kattegatt-Fischerei der Rückgang im Schollenbestand des Kattegatt nicht zu bemerken gewesen ist, während doch in Dänemark begründete Klagen laut geworden sind. Auch die Statistik der Internationalen Meeresforschung weist den Rückgang nach. Danach sind 1928 rd. 1.000.000 kg (ca. 30 %) Schollen weniger gefangen worden als 1927. In den gleichen Jahren ist dagegen der deutsche Fang nicht unerheblich (ca. 20 %) gestiegen. (Vergl. Tab. X).

D. Die Gesamtfischerei im Kattegatt.

Die oben gemachte Gegenüberstellung des Ertrages der deutschen Schollenfischerei im Kattegatt zum Ertrage des gesamten Schollenfanges in dem Gebiet gab Veranlassung, auch das Verhältnis des deutschen Fanges an anderen Nutzfischen im Kattegatt zum Gesamtertrag dieser Fische an der Hand der Statistik der Internationalen Meeresforschung zu betrachten. Die Zusammenstellung ist in der Tabelle XIII gegeben.

Dabei sei vorausgeschickt, dass in der genannten Statistik nur die Fänge Däne-

marks und Deutschlands im Kattegatt aufgeführt sind, da „die kleine Menge von Fischen, die durch schwedische Fischer aus dem Kattegatt gelandet werden, unter der Rubrik »Skagerrak« mitnachgewiesen wird". Die Spalte *a* »Gesamtfang« der folgenden Tabelle XIII umfasst daher den Ertrag der Fischereien Dänemarks und Deutschlands, und da Spalte *b* den deutschen Fang für jeden Fisch angibt, ergibt die Differenz den Ertrag der dänischen Fischerei für den betreffenden Fisch.

Tabelle XIII. Gesamtanlandungen aus dem Kattegatt in 1000 kg.

	1924		1925		1926		1927		1928	
	a Gesamtfang	*b* Deutscher Anteil	*a* Gesamtfang	*b* Deutscher Anteil	*a* Gesamtfang	*b* Deutscher Anteil	*a* Gesamtfang	*b* Deutscher Anteil	*a* Gesamtfang	*b* Deutscher Anteil
Kabeljau (Cod)	8008	1309	8366	1272	8956	1502	8574	951	8869	1130
Wittling	542	539	609	604	457	450	261	256	259	253
Pollack u. Seelachs	214	214	138	138	186	184	90	88	144	136
Schellfisch	389	325	557	325	531	322	167	115	169	69
Scholle	1952	94	2267	80	2308	66	3244	53	2258	64
Seezunge	43	14	48	15	36	7	31	4	49	9
Steinbutt	59	26	46	14	55	22	40	10	52	11
Tarbutt	104	47	67	22	91	39	66	21	79	21
Echte Rotzunge	3	2	5	4	6	5	12	7	8	7
Knurrhahn	73	73	49	49	98	98	62	62	21	21
Petermann	314	314	109	109	171	171	63	63	45	45
Katfisch	53	53	38	38	47	47	39	39	27	27
Hering	5144	81	4793	67	3768	—	4578	—	5865	—
Makrele	2210	1	3524	—	2444	2	2993	—	4128	—
Aal	858	—	913	—	1031	—	1022	—	919	—
Hornhecht	289	—	192	—	236	—	650	—	1173	—
Kliesche	957	22	1286	24	1488	14	1403	12	1299	11
Flunder	472	4	579	4	644	9	724	6	655	—
Seehase	198	—	178	—	244	—	674	—	499	—

Die oben erwähnte Verschiedenheit in den Fischereibetrieben Dänemarks und Deutschlands hat ein interessantes Ergebnis. Wie die Tabelle zeigt, werden einzelne Fischarten nur oder fast nur von deutschen Fischern gefangen, während andere fast oder ganz ausschliesslich Objekte der dänischen Fischerei sind. Zu ersteren gehören wichtige Gadiden wie Wittling, Pollack, Seelachs in manchen Jahren (1924) auch der Schellfisch, ferner Knurrhahn, Petermann und Katfisch. Zu letzteren: Hering, Makrele, Kliesche, Flunder, Aal und Seehase. Dieses eigenartige Verhältnis, das für viele Fischarten nicht allgemein bekannt sein dürfte, sei hier nur kurz erwähnt. Es wird sich verlohnen, im anderen Zusammenhang einmal ausführlich darauf zurückzukommen, da ihm grosse Bedeutung für allgemeine Fragen, die die Meeresforschung berühren, zukommen dürfte. Das kleine und leicht zugängliche Kattegatt gilt als ein stark befischter Meeresteil

und doch blieben, wenn die deutschen Dampfer dort keine Fischerei betreiben würden, grosse Mengen von wertvollen Fischen unausgenutzt. Auch heut geniessen diese Fische noch während des grössten Teiles des Jahres (in den Monaten, in denen die Dampferfischerei dort garnicht oder nicht intensiv betrieben wird) eine Schonung. Andererseits gibt es eine Anzahl von Fischen, die von der Dampferfischerei nicht erfasst werden, und die in den Meeren nicht ausgenutzt werden, wo eine so intensive Küstenfischerei fehlt, wie sie Dänemark hat.

E. Die Zukunft der deutschen Fischerei im Kattegat.

Die Prognose, die der deutschen Kattegattfischerei zu stellen ist, ist keine erfreuliche. Wir sahen oben, dass die Verringerung der deutschen Befischung des Kattegatts nicht auf einen Rückgang der Fänge zurückzuführen ist, sondern in der fortschreitenden Entwicklung der deutschen Dampferflotte zu immer grösseren Fahrzeugen und immer stärkerer Maschinenkraft ihre Ursache hat. Mit dem Ausscheiden der kleineren Dampfer wird allmählich die Befischung des Kattegatts mehr und mehr zurückgehen, vielleicht in einer Reihe von Jahren ganz aufhören. Es besteht aber die Möglichkeit, dass die grösseren neu erbauten Nordseekutter, welche keine Bünn haben, an Stelle der Fischdampfer in den Wintermonaten die Reisen in das Kattegatt aufnehmen. Das wird um so eher eintreten, wenn die Herings- und Sprottfischerei in der deutschen Bucht der Elbe ausbleibt, oder wenn sich den Kuttern durch das Heranbringen von gutbezahlten Edelfischen aus dem Kattegatt die Möglichkeit zu lohnenden Reisen bietet.

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Die Scholle *(Pleuronectes platessa)* an der Norwegischen Skagerrak-Küste.

Von

Paul Bjerkan, Bergen.

I. Biologisches.

Leider liegen für unsere Südküste sehr wenig Untersuchungen über die Scholle (*Pleuronectes platessa*) vor. Dies kommt daher, weil sie für die Fischerei von wenig Interesse ist. Sie kommt überall vor, aber meistens nur verstreut, und ist darum nur für die nächsten Marktplätze und zum Selbstgebrauch der Fischer gefischt worden. In den letzten Jahren hat aber, wie es scheint, die Verwendung der Dänischen Wade einige bessere Bestände nachgewiesen. Ob dies nur eine zeitweilige Erscheinung ist, oder ob sich wirklich mehr Schollen vorfinden, als man mit den älteren Geräten, Stellnetz und Langleine, nachweisen konnte, ist eine Frage, die hoffentlich schon diesen Sommer näher untersucht werden wird. Zur Zeit kann ich nur einen kurzen Bericht über einige Zählungen und Messungen geben, die in den Jahren 1909—10 gemacht wurden, sowie einige Angaben nach einer leider nicht sehr ausführlichen Statistik; zur Ergänzung habe ich in den Monaten Januar—März dieses Jahres an einigen Stellen unserer Südküste einige ganz kursorische Untersuchungen gemacht über Fang, Alter und Grösse der Scholle. Das Material ist sehr klein, aber in Verbindung mit einigen Daten in unserer Fischereistatistik scheint es doch zu bestätigen, dass der Schollenbestand an unserer Südküste bedeutend stärker ist, als man nach dem Fang mit den früher verwendeten Geräten annehmen möchte. Dasselbe hat sich ja, wie bekannt, auch in unserem nördlichen Gewässer, bei den Lofoten und nordwärts erwiesen.

Die Untersuchungen über die Grösse der Scholle, die an einigen der grösseren Marktplätze in den Jahren 1909—10 gemacht wurden, galten nur administrativen Zwecken und zwar hauptsächlich der Frage, ob man die lokalen Verbote gegen den Gebrauch kleinerer Sperrnetze und Waden aufheben und Mindestmasse für einige der wichtigsten Bodenfische einführen sollte.

Der Plan der Messungen und Zählungen war von dem damaligen Fischereidirektor Dr. Johan Hjort entworfen und von Knut Dahl, damals Assistent der Fischereiuntersuchungen, ausgeführt worden. Die Resultate der Untersuchungen wurden von Dahl in »Årsberetning vedk. Norges Fiskerier« H. 1. 1910 veröffentlicht.

Die Messungen und Zählungen wurden an den Fischmärkten in Oslo (Kristiania), Halden (Frederikshald), Frederikstad, Kragerö, Arendal und Kristiansand zwischen Mai—Juli 1909 und Mai—Juli 1910 vorgenommen, etwas verschieden an den verschiedenen Stellen, aber mindestens während eines ganzen Jahres. Untersucht wurden: Dorsch, Scholle, Flunder und Aal. Hier wollen wir nur das Resultat, insofern es der Scholle gilt, betrachten. In Halden kamen Schollen nicht vor, wenigstens nicht so viele, dass Messungen gemacht werden konnten.

An den übrigen Marktplätzen wurden die Schollen in drei Kategorien gemessen und gezählt: über 26 cm, zwischen 20 und 26 cm und unter 20 cm. In Frederikstad wurde die Anzahl der Schollen über 26 cm leider nicht gezählt. Die Messungen und Zählungen gaben das folgende Resultat:

Tab. I.

Markt	Über 26 cm		20—26 cm		Unter 20 cm	
	Anzahl	%	Anzahl	%	Anzahl	%
Frederikstad	?	—	7560	—	3500	—
Oslo	46497	96,7	1600	3,3	—	0,0
Kragerö	763	58,0	528	40,2	23	1,8
Arendal	1421	66,7	444	20,8	266	12,5
Kristiansand	1537	67,0	710	31,0	50	2,0

Zu dem Material von Kristiansand wird von Dahl bemerkt, dass darin bedeutende Mengen Dänische Schollen waren; auch das Material von Oslo enthält zum Teil Dänische Schollen. Hierdurch wird das Resultat für die Norwegischen Verhältnisse etwas unsicher, aber daran ist jetzt nichts zu ändern. Die Zahlen von Frederikstad zeigen eine grosse Menge kleiner Schollen unter 20 cm. Dies hat sich jetzt, wie unten zu konstatieren ist, vollständig geändert. In Oslo werden kleine Schollen unter 20 cm nicht verkauft und nur 3,3 % zwischen 20 und 26 cm. Kragerö, Arendal und Kristiansand zeigen etwa zwischen 30 und 40 % Schollen unter 26 cm, davon sind in Arendal sogar 12,5 % unter 20 cm; für die beiden anderen Städte zeigt die letzte Kategorie nur 1,8 und 2 %.

Wie man sieht, wurden damals in den Küstenstädten ausserhalb Oslo ziemlich grosse Mengen von kleinen Schollen verkauft, in einem Falle ist sogar ein beträchtlicher Teil unter 20 cm.

Diese Messungen sind alles, was aus früheren Tagen für die Norwegische Südküste vorliegt. Als Material zur Beurteilung über die Grösse des Schollenfanges wird unten in 2 Tabellen der Fang von Schollen während der Jahre 1908—1927 nach der Fischereistatistik gegeben (Tab. II—III).

Die Angaben sind zur besseren Übersicht in 2 Dekaden aufgestellt, 1908—1917 und 1918—1927. Für jedes der zehn Jahre ist das durchschnittliche Gewicht berechnet, und

daneben auch der durchschnittliche Wert in Kronen angegeben. Die Angaben umfassen die Küstenstrecke von der Schwedischen Grenze (Östfold) bis Åen Sire, westlich von Flekkefjord (Aust-Agder); sie sind nach Verwaltungsgebieten (Fylker) aufgestellt. Was Oslo betrifft, so ist zu bemerken, dass das Material natürlich nicht aus den Hafengebieten der Stadt stammt, sondern von den Distrikten zugeführt ist. Die Zahlen sind auch nicht ganz nach der offiziellen Statistik gegeben. Diese enthält nämlich, der Einstellung der verschiedenen Autoren entsprechend, bald alles was umgesetzt ist und bald überhaupt keine Mengen. In den letzten Jahren ist man aber dem Vorgehen des Vereins zur Förderung der Fischereien innerhalb Dröbak gefolgt und dessen Angaben habe ich hier auch für die früheren Jahre benutzt, um einheitlichere Zahlen zu bekommen.

Wie man sieht, scheint das Gewicht und noch mehr der Wert gestiegen zu sein. Zum Teil ist nach meiner Ansicht dieses Steigen durch genauere Angabe des Fanges bewirkt worden, und ist folglich nur scheinbar. Diese Auffassung wird auch durch die mündlichen Angaben der Bevölkerung der betreffenden Küstenstrecke bestärkt. Für viele Distrikte wird allgemein ausgesprochen, dass die Scholle in der letzten Zeit sehr selten geworden ist.

Tab. II. Der Schollenfang 1908—1917, Gewicht in kg nach Verwaltungsbezirk, nebst Durchschnittsfang und Durchschnittswert.

Fylke	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	Durchschnitt 1908—1917	
											Gewicht kg	Wert Kr.
1. Oslo	3872	3122	3538	3482	4435	6659	11895	12265	11050	12400	7272	9372
2. Østfold.....	29130	29510	26230	5750	1800	3700	2400	2100	1800	1800	10422	4677
3. Akershus.....	240	800	620	470	100	100	630	100	400	200	366	315
4. Buskerud.....	200	—	—	500	500	—	50	500	10100	2000	1385	2098
5. Vestfold.....	2450	5900	2910	2380	1300	1400	2040	2400	3500	21600	4588	5132
6. Telemark.....	2000	500	300	—	—	—	—	—	—	—	280	143
7. Aust-Agder....	8200	100	560	580	90	600	100	100	900	100	1133	727
8. Vest-Agder	300	—	400	400	250	400	200	200	350	500	300	132
Skagerrak-Küste von Norwegen.	46392	39932	34558	13562	8475	12859	17315	17665	28100	38600	25746	22596

Für Östfold aber und dann speciell für das Hvaler-Gebiet ist das Quantum ganz sicher während der letzten Jahre gestiegen, besonders von 1923 ab. Dies wird wahrscheinlich durch die Verwendung der Dänischen Wade bewirkt sein. Die angegebene Steigerung der Menge in Telemark von 1922 ab erwies sich später als Wirkung einer Verwechselung mit der Rotzunge (*Pl. cynoglossus*). Die betreffenden Zahlen sind in der Tabelle III in Klammern angeführt, und in den Summen nicht einbegriffen. Übrigens sind die Angaben für Telemark — meistens ist überhaupt kein Quantum angegeben — sehr problematisch. Wie später gezeigt wird, habe ich von Langesund (gehört zu Telemark) Messungen ganz grosser Fänge von Schollen bekómmen. Es werden folglich da und

Tab. III. Der Schollenfang 1918—1927, Gewicht in kg nach Verwaltungsbezirk, nebst Durchschnittsfang und Durchschnittswert.

Fylke	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	Durchschnitt 1918—1927	
											Gewicht kg	Wert Kr.
1. Oslo	14740	14700	14600	15100	15645	16500	12400	11300	13000	7000	13499	29581
2. Østfold.....	2000	3600	5300	4220	6200	82000	72900	52100	26700	100500	35552	53205
3. Akershus....	500	400	200	730	1000	1900	1100	1000	640	1400	887	1623
4. Buskerud....	1100	1000	—	1700	4200	2300	1200	30500	600	400	4300	4732
5. Vestfold.....	12300	11200	11800	13100	11000	17300	7300	11200	9030	9800	11403	18410
6. Telemark....	—	—	—	—	*(10100	53800	30800	30200)	—	—	*(12490	8711)
7. Aust-Agder ..	600	100	—	400	100	200	1300	2900	4200	1600	1140	1123
8. Vest-Agder ..	100	100	100	100	1000	600	3900	400	5800	6500	1860	2314
Skagerrak-Küste von Norwegen	31340	31100	32000	35350	39145	120800	100100	109400	59970	127200	68641	110988

* (...) Rotzungen *(P. cynoglosus)* und nicht in den Summen einbegriffen.

wahrscheinlich auch in den andern Distrikten viele Fänge von Schollen gelandet, die nicht in die Angaben der Statistik kommen.

So viel über die Statistik.

Zum Zwecke der Bearbeitung dieses Berichtes sind einige ganz kursorische Erhebungen über den Schollenbestand unserer Südostküste gemacht und gesammelt worden. Die Untersuchungen haben sich nur über 2—3 Monate erstreckt, nämlich Januar bis März dieses Jahres, und sind folglich nur als ganz gelegentliche zu betrachten. Als ein Supplement des früheren, mehr als spärlichen, Materials können sie doch von Bedeutung sein.

Es wurde versucht, Messungsmaterial von Oslo, Frederikstad, Langesund und Arendal zu bekommen. Was Oslo betrifft, zeigte es sich, dass man während des betreffenden Zeitraums kein Zufuhr an Schollen von der Südküste gehabt hatte; sie war jedenfalls nur so gering, dass mein Vertreter, einer der bedeutendsten Fischhändler des Fischmarkts Oslos, keine Schollen dieser Gegend messen konnte. Die Zufuhr an Schollen erfolgte während der Zeit über Drontheim (Nord-Norwegen) und von Dänemark. Gelegentlich kamen Schollen von Egersund (Rogaland).

In Frederikstad hatte man im Januar eine geringe Zufuhr von Schollen aus dem Hvaler-Distrikt, wo sie mit der Dänischen Wade gefangen wurden. Ich hatte selbst Gelegenheit, einige der gelandeten Fänge anzusehen und einige Messungen vorzunehmen. Ein Versuch, noch mehr Messungsmaterial durch Stellvertreter zu bekommen, war nicht gelungen, da die Fischerei auf Schollen kurz nachher zu Ende war.

Das Resultat der Messungen in Frederikstad ist in Tab. IV dargestellt. 4 kleine Fänge, die von Hvaler eingebracht worden waren, sind gemessen.

Wie man sieht, liegt die Länge der Schollen sehr gleichmässig zwischen 26 und 40 cm, die Durchschnittslänge war ca. 33 cm. Eine einzige Scholle von 53 cm wurde

gefangen, dies war aber, wie die Leute versicherten, eine ganz seltene Erscheinung. Die Fischerei in den Sunden zwischen den Hvaler-Inseln wurde in einer Tiefe von 40 bis 80 m betrieben. Die Länge der Schollen war nach den Mitteilungen sehr gleichmässig von der Grösse, wie sie die gemessenen Fänge zeigen. Sehr selten wurden kleinere Schollen mit gefangen. Im Frühling wurden aber auch kleinere Schollen dem Markte zugeführt, wenn das seichtere Gewässer mit Stellnetzen und Langleinen befischt wurde.

Wie aus der Statistik zu ersehen ist, ist, wie früher erwähnt, von 1923 ab eine Steigerung in dem Schollenquantum von Östfold deutlich merkbar. Diese Steigerung ist durch

Tab. IV. Messungen von 4 Schollenfängen, gelandet in Frederikstad 14. Januar 1930. — Mit Dänischer Wade gemacht.

Länge in cm	Fang I	Fang II	Fang III	Fang IV	Zusammen	
					Anzahl	Prozent
26	1	1	2	—	4	2,6
27	2	1	2	1	6	3,9
28	2	—	2	2	6	3,9
29	3	3	4	2	12	7,7
30	5	1	6	4	16	10,3
31	3	3	3	4	13	8,4
32	3	3	7	2	15	9,7
33	1	6	6	5	18	11,6
34	4	6	6	3	19	12,2
35	2	2	5	1	10	6,5
36	2	2	3	2	9	5,8
37	2	1	5	1	9	5,8
38	5	2	1	1	9	5,8
39	2	..	2	2	6	3,9
40	1	..	1	..	2	1,3
41	..	..	..	..	..	..
42	..	..	..	..	..	..
43	..	..	..	..	..	..
44	..	..	..	..	..	..
45	..	..	..	..	..	..
46	..	..	..	..	..	..
47	..	..	..	..	..	..
48	..	..	..	..	..	..
49	..	..	..	..	..	..
50	..	..	..	..	..	..
51	..	..	..	..	..	..
52	..	..	..	..	..	..
53	—	1	—	—	1	0,6
Anzahl	38	32	55	30	155	100,0
Durchschnitt	33,0 cm	33,4 cm	32,8 cm	32,5 cm	32,9 cm	

die Angaben von Frederikstad bewirkt. Da ich diese hohen Zahlen etwas zweifelhaft fand, machte ich dort während meines Aufenthalts einige Nachfragen. Ich dachte, dass auch hier in irgend einer Weise Verwechselungen mit anderen Arten vorzugsweise wohl mit der Rotzunge stattgefunden haben könnten. Der Sammler des Materials versicherte aber, dass dies nicht der Fall wäre. In manchen Zeiten des Jahres sollen hier ganz bedeutende Mengen von Schollen angebracht werden, viel mehr als man nach den Fängen, die im Januar gelandet wurden, erwarten konnte.

Nach dieser Auskunft muss tatsächlich eine Steigerung eingetreten sein, und, wie es scheint, hängt dies mit der verbesserten Fischereitechnik, insbesondere mit dem Gebrauch der Dänischen Wade, zusammen. Dies scheint anzudeuten, dass der Schollenbestand bis jetzt nicht so gut ausgenutzt worden ist, wie es möglich gewesen wäre. Seit 1923 sind im Hvaler-Gebiet viel grössere Mengen von Schollen gefischt worden als

Tab. V. Messungen von 3 Schollenfängen, gelandet in Langesund Februar-März 1930. Mit Dänischer Wade gemacht.

Länge in cm	Fang I	Fang II	Fang III	Zusammen	
				Anzahl	Prozent
27	2	..	1	3	0,3
28	..	..	3	3	0,3
29	4	6	1	11	1,1
30	13	23	4	40	4,0
31	20	40	2	62	6,0
32	30	62	5	97	9,8
33	23	88	6	117	11,8
34	29	87	3	119	12,0
35	35	88	3	126	12,7
36	30	61	5	96	9,7
37	21	61	7	89	9,0
38	19	43	5	67	6,8
39	9	31	3	43	4,3
40	6	23	4	33	3,3
41	3	22	—	25	2,5
42	10	12	—	22	2,2
43	3	5	1	9	0,9
44	2	10	—	12	1,2
45	2	3	1	6	0,6
46	1	6	—	7	0,7
47	—	1	—	1	0,1
48	—	3	1	4	0,4
Anzahl	262	675	55	992	100,0
Durchschnitt	35,0 cm	35,4 cm	35,1 cm	35,3 cm	..

früher und doch scheint der Bestand nicht abgenommen zu haben. 1927, das letzte Jahr der Statistik, zeigt für Östfold höhere Zahlen als alle früheren Jahre.

Das Wachstum der Schollen scheint vorzüglich zu sein. Nach einigen Stichproben zeigte es sich aus den Otolithen, dass Schollen von 2 Jahren bis 28 cm erreichen können, und dass die Schollen zwischen 28 und 36 cm etwa 3 Jahre alt sind. Die Schollen waren trotz der Jahreszeit von sehr guter Qualität.

Von Langesund (Telemark) liegen Messungen von 3 Fängen aus Februar—März 1930 vor. Einer der Fänge ist verhältnismässig gross, im ganzen 675 Stück. Tabelle V zeigt, wie die Längen der Schollen dieser Fänge verteilt sind.

Tab. VI. Länge, Alter und Gewicht von 20 Schollen, bei Arendal am 10. März 1930 mit Langleinen gefangen.

Länge in cm	Jahrgang			Anzahl	Prozent	Gewicht in Gram pr. Stück	Anmerkungen
	1928	1927	1926				
27.....	2	..	..	2	10	240	
28.....	..	1	..	1	5	260	
29.....	..	—	..	—	—	—	
30.....	..	1	..	1	5	300	Gesamtgewicht: 8650 gr
31.....	..	2	..	2	10	290—370	
32.....	..	2	..	2	10	350—400	
33.....	..	—	..	—	—	—	Durchschnittliche Länge: 33,15 cm
34.....	..	6	..	6	30	420—520	
35.....	..	2	..	2	10	450—500	
36.....	..	2	..	2	10	510—560	Durchschnittliches Gewicht: 433 gr
37.....	..	—	1	1	5	590	
38.....	..	—	—	..	..	—	
39.....	..	—	—	..	..	—	
40.....	..	—	—	..	..	—	
41.....	..	—	—	..	..	—	
42.....	..	—	1	1	5	750	
Total.....	2	16	2	20	100	—	

Die Schollen fallen hier etwas grösser aus als bei Frederikstad, sie massen 27—48 cm, die durchschnittliche Länge war etwa 35 cm. Wahrscheinlich sind sie auch in etwas grösseren Tiefen gefangen worden, darüber habe ich aber keine sicheren Nachrichten.

Aus der Umgebung von Arendal, nahe Tromöy, habe ich einige Messungen mit Altersbestimmungen und Gewichtsangaben bekommen. Das Material ist von dem Vorsteher der Fischbrutanstalt in Flödevigen, Alf. Dannevig gesammelt worden (Tab. VI). Es ist aber nur klein, und nach den Mitteilungen Dannevigs kommt die Scholle jetzt sehr spärlich in diesem Gebiete vor. Die 20 Schollen der Probe sind mit Langleinen gefangen.

Die Grösse dieser Schollen scheint mit der des Hvaler-Gebietes zusammen zu fallen, durchschnittliche Länge etwa 33 cm, eine einzige Scholle mass 42 cm.

Die Altersuntersuchungen zeigen ein vorzügliches Wachstum, das dem des Hvaler-Gebietes etwa gleich ist.

II. Historisches.

Bei dem jetzigen Stand der Schollenfrage können einige Bemerkungen über unsere gesetzlichen Bestimmungen, die Scholle betreffend, von Interesse sein.

Nach dem Gesetz wird die Scholle zusammen mit Dorsch, Flunder und anderen Bodenfischen an unserer Skagerrak-Küste durch die Verbote der Anwendung kleiner Sperrnetze und Waden in gewisser Weise beschützt. Seit der Mitte des vorigen Jahrhunderts hatten die Bewohner der genannten Küstenstrecke sich nämlich darüber beklagt, dass die verschiedenen engmaschigen Fischergeräte und vornehmlich die Sperrnetze für die Fischerei der Bodenfische sehr schädlich wären. Durch diese Geräte wurden Hering, Sprotten, Makrele, Meerforellen, Aal und zuweilen Kohlfisch gefangen, aber man fängt damit je nach der Jahreszeit und Lokalität, auch Jungstadien der essbaren Bodenfische. Die Konstruktion der Geräte kann dies nicht verhindern, und deshalb kamen die obenerwähnten Verbote als das einzig mögliche Mittel gegen die Zerstörung der Jungfische. Sie sind auf Grund des Gesetzes vom 5ten Juni 1869, das durch das Gesetz vom 28ten April 1888 ersetzt wurde, durchgeführt worden. Im Jahre 1910 waren 14 solche Verbote gegen kleinere Sperrnetze und Waden von der Schwedischen Grenze bis Kristiansand in Wirksamkeit und etwa dieselbe Anzahl gilt auch jetzt noch.

Diese Verbote bilden aber viele Hindernisse für das Ausnutzen der pelagischen Fische wie Hering, Sprott, Makrele u. s. w. Dazu sind die Grenzen zwischen den grösseren für diese Fische eingerichteten Geräten und den kleineren, die verboten sein sollten, sehr schwankend und Übertretungen der Verbote sehr häufig.

In den Jahren 1909—10 wurde dann neben den früher erwähnten Messungen der essbaren Bodenfische, die an den verschiedenen Marktplätzen verkauft wurden, auch Untersuchungen über die Wirkung der Wadenverbote vorgenommen. Auf Grund dieser Untersuchung schlug der Leiter derselben, Knut Dahl, vor, dass die Verbote aufgehoben und Mindestmasse beim Verkauf für Dorsch, Scholle, Flunder und Aal eingeführt werden sollten. Für die Scholle schlug er ein Mindestmass von 26 cm vor.

Dieser Vorschlag wurde dann an die interessierten Gemeindebehörden, die Fischereigesellschaften und andere geschickt. Etwa 65 % der Behörden und Gesellschaften sprachen sich für das für die Scholle vorgeschlagene Mindestmass, 26 cm, aus, die übrigen wünschten kleinere Mindestmasse.

In der Fischereiratsversammlung in 1911 schlug der damalige Fischereidirektor, Dr. Hjort, ein Mindestmass von 25 cm für die Scholle vor. Auch ein neues Gesetz, das Gelegenheit geben sollte, Mindestmasse einzuführen, wurde vorgeschlagen. Das Gesetz wurde in seinen Hauptzügen von der Versammlung angenommen, die Einführung eines Mindestmasses aber aufgeschoben.

Das Hjort'sche Gesetz zur Regelung der Geräte und Einführung von Mindest-

massen wurde im Jahre 1914 durch den Reichstag (Storting) angenommen. Ein Mindestmass ist jedoch bis jetzt nicht eingeführt worden, weder für Dorsch noch Scholle an der Südküste. Die Sache wird jedoch weiter bearbeitet.

In 1916 wurde von der Östlandschen Fischereigesellschaft ein Komitee eingesetzt, das über die Aufhebung der Wadenverbote und die Einführung von Mindestmassen beraten sollte. Das Resultat war der Vorschlag, dass die Verbote aufgehoben und Mindestmasse, 20 cm für Dorsch, Scholle und Flunder und 34 cm für Aal, eingeführt werden sollten. Dieser Vorschlag wurde an den Fischereidirektor geschickt, und dort weiter bearbeitet.

Der Fischereidirektor legte die Sache der Fischereiratversammlung in 1920 vor mit dem Vorschlag: Aufhebung der Verbote gegen Waden und Sperrnetze und Einführung eines Mindestmasses von 25 cm für Dorsch und Scholle und 20 cm für Flunder. Das Schicksal des Vorschlags war, dass die Mehrzahl der Versammlung für die niedrigeren Mindestmasse der Östlandschen Fischereigesellschaft stimmte. Der Fischereidirektor (Asserson) hielt aber seinen Vorschlag aufrecht und schickte die Sache an das Departement.

Die Sache liegt jetzt also so, dass die Verbote gegen kleinere Sperrnetze und Waden wahrscheinlich binnen kurzer Zeit aufgehoben werden. Als Ersatz müssen dann Mindestmasse beim Verkauf eingeführt werden. Die Bevölkerung der Südküste scheint für die niedrigeren Mindestmasse eingetreten zu sein, also 20 cm für die Scholle. Die wissenschaftlichen Fachleute und die Fischereiverwaltung halten an höheren Mindestmassen fest, wenn die Wadenverbote aufgehoben werden sollen. Prinzipiell ist 26 cm als das beste Mindestmass vorgeschlagen, aber die Administration ist für einen Kompromiss, ein Mindestmass von 25 cm für die Scholle, eingetreten.

On the Decrease in the Yield of the Plaice Fishery in the Kattegat and Skagerak in the last Decennaries and Causes of the same.

By

A. C. Johansen.

1. General remarks on the Stock of Plaice in the Kattegat and the Skagerak.

The stock of plaice in the Skagerak has the same racial features as that in the north eastern parts of the North Sea. Part of the Kattegat stock has the same racial characters as the Skagerak stock, while another part belongs to the so-called Baltic race which has a smaller number of vertebræ and finrays than the North Sea race and aquires maturity at a lower age and a smaller size than the other race. In the north and north-eastern parts of the Kattegat plaice of the North Sea race prevail while in the Bay of Aalborg and in the southern parts of the Kattegat, including the Sound, the majority of the stock is composed of plaice of the Baltic race[1]).

The spawning places of the North Sea race in the Skagerak and the Kattegat are found in comparatively salt water at a depth of about 20 to 80 metres in these waters, and in the eastern parts of the North Sea from which the Jutland Current carries numerous eggs and larvæ into the Skagerak. The spawning of the Baltic plaice in the Kattegat takes place mostly in the southern and south-eastern parts of that sea, at a depth of about 15 to 50 metres, in water with a salinity of about 28 to 32 $^0/_{00}$.

The 0-group plaice is most frequently found in the following areas[2]).

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[1]) comp.: A. C. Johansen: Bericht über die dänischen Untersuchungen über die Schollenfischerei etc. Medd. Komm. f. Havunders. Ser. Fiskeri Bd. III. København 1910. Idem: On some characters of the Baltic Plaice which have changed during the last decennaries. Rapports et Procès-Verbaux. Vol. LIV. 1928.

[2]) See e. g. A. C. Johansen: Ueber die Schollenfischerei im Kattegat etc. Rapports et Procès-Verbaux Vol. V. Copenhagen 1904.

Anton Fr. Bruun: Quantitative investigations of the 0-group and I-group of Plaice etc. — Medd. Komm. f. Havundersøgelser. Ser. Fiskeri, Bd. VIII, Nr. 5. 1927.

K. A. Andersson: in Report of the Transition Area Committee. Rapports et Procès-Verbaux, Vol. LXVI. 1930.

1) The Skagerak coast of Jutland.
2) The east coast of Jutland between the Scaw and Als Odde.
3) Certain places off the western coast of Sweden between Hällö and the Kullen.

The prevailing growing places of the I-group and the II-group are found in the ollowing areas[1]).

1) Off the Skagerak coast of Jutland at a depth of about 1 to 20 metres.
2) The Aalbæk Bay including Hertha's Flak.
3) The Banks at Læsø Rende and north of that Island.
4) The Aalborg Bay between the Stensnæs and Als Odde.
5) Certain places off the Swedish west coast between Hållö and the Kullen.

In the Kattegat and the Skagerak, the plaice remain only to a certain extent during their whole life cyclus. A considerable part of the eggs and the larvæ is carried by the salt bottom current into the Belt sea or, under certain circumstances, by high water and western winds through the Sound into the Baltic. But then, on the other hand, a great deal of grown-up plaice migrate from the Baltic and the Belt Sea into the Kattegat[2]). When maturity approaches many plaice of the North Sea race go from the Kattegat to the Skagerak and to the North Sea to spawn, and between the North Sea and the western Skagerak a frequent interchange of younger and older individuals takes place[3]).

The stock of plaice at the southern and south-western coast of Norway is not without relation to the stock in the southern part of the Skagerak and the Kattegat. It has happened that marked plaice which have been planted out in the southern part of the Skagerak and the Kattegat have been caught again off the south-western coast of Norway. (v.: A. C. Johansen[2]) and Arvid R. Molander[1])).

2. The Yield of the Plaice Fishery in the Period 1901—1929.

Tables 1—3 contain a survey of the yield of the plaice fishery (in tons) in the Skagerak and the Kattegat during the years 1901—29. As far as Denmark is concerned the information on the yield has been taken from the official Fiskeri Beretning[4]). On the part of Sweden and Germany the yields are quoted from the "Bulletin Statistique" which information in the case of a few years is supplemented from the official statistics of fisheries published in these two countries. As to Norway the yield is quoted from a paper by

[1]) See e. g. A. C. Johansen: Contributions to the Biology of the Plaice III. Medd. Komm. f. Havundersøgelser. Ser. Fiskeri, Bd. III. 1908.

Aage J. C. Jensen: Investigations on the Stock of Plaice in the Kattegat etc. The present Report.

Arvid R. Molander: Investigations of Plaice off the west-coast of Sweden. The present Report.

[2]) A. C. Johansen: Om Rødspætten og Rødspættefiskeriet i Beltfarvandet. København 1912.

[3]) A. C. Johansen: Contributions to the Biology of the Plaice II. København 1907.

Filip Trybom: Svenska rödspättemärkningar och mätningar 1904 och 1905. Svenska Hydr. Biol. Komm. Skrifter III. 1908.

[4]) On the distribution of the yield in the two seas, the Skagerak and the Kattegat during the years 1901—08 v.: A. C. Johansen: Rødspættespørgsmaalet. Dansk Fiskeritidende. No. 7. 1922.

Mr. Paul Bjerkan, published in the present report, whose statements on the yield concerning certain years differ essentially from the information in the "Bulletin Statistique". It appears from Table 1 that the total yield in the Skagerak and the Kattegat has decreased rapidly during the period dealt with here. A consideration of the average yield for periods of ten years gives the following result:

The period from 1901—10 an average of 5206 tons
— — 1911—20 - — - 4194 —
— — 1921—29 - — - 3562 —

As the stock of plaice in the Kattegat belongs partly to another race than that of the Skagerak and as, moreover, the physical conditions of these waters are essentially different, it may be of interest to examine the yield of the fisheries in the two seas separately. As far as Denmark and Germany are concerned a distribution of the yield over the two waters is possible, and as to Norway the whole yield comes from the Skagerak. In the case of Sweden, however, a distribution is impossible, the main part of the Swedish yield, however, comes from the Kattegat.

Table 1. Total Yield in Tons of the Plaice Fishery in the Kattegat and Skagerak in the Years 1901—29.

Year	Denmark	Sweden	Germany	Norway	Total	Year	Denmark	Sweden	Germany	Norway	Total
1901	c. 4000	527	..	..	c. 4500	1916	2555	365	66	28	3014
1902	- 5500	639	..	..	- 6100	1917	2884	501	85	39	3509
1903	- 5300	918	179	..	- 6400	1918	2443	463	29	31	2966
1904	- 4900	819	317	..	- 6000	1919	4132	387	206	31	4756
1905	- 3000	740	355	..	- 4100	1920	2909	300	194	32	3435
1906	- 3200	696	331	..	- 4200	1921	2441	438	105	35	3019
1907	- 4900	637	395	..	- 5900	1922	2677	429	141	39	3286
1908	- 4500	658	402	46	- 5600	1923	2593	525	115	120	3353
1909	3569	608	328	40	4545	1924	2256	586	170	100	3112
1910	3708	606	307	35	4656	1925	3011	549	149	109	3818
1911	4089	599	292	14	4994	1926	2969	376	135	59	3539
1912	3923	407	268	8	4606	1927	4056	454	84	127	4721
1913	3522	397	266	13	4198	1928	3059	457	130	81	3727
1914	4447	601	138	17	5203	1929	2696	?	110	?	c. 3400
1915	4019	962	101	18	5100						

Table 2. Total Yield in Tons of the Plaice Fishery in the Kattegat (including the Sound) in the Years 1901—1929.

Year	Denmark	Sweden	Germany	Total	Year	Denmark	Sweden	Germany	Total
1901	c. 2800	527	?	c. 3300	1906	c. 2300	696	203	c. 3200
1902	- 3900	639	?	- 4500	1907	- 3900	637	128	- 4700
1903	- 3800	918	58	- 4800	1908	- 3300	658	169	- 4100
1904	- 3300	819	114	- 4200	1909	2475	608	142	3225
1905	- 2200	740	191	- 3100	1910	2664	606	183	3453

Year	Denmark	Sweden	Germany	Total	Year	Denmark	Sweden	Germany	Total
1911	2780	599	221	3600	1921	1999	438	42	2479
1912	2679	407	149	3235	1922	2015	429	71	2515
1913	2573	397	171	3141	1923	2022	525	96	2643
1914	3774	601	110	4485	1924	1858	586	94	2538
1915	3397	962	90	4449	1925	2186	549	80	2815
1916	2105	365	66	2536	1926	2243	376	66	2685
1917	2292	501	85	2878	1927	3191	454	53	3698
1918	2140	463	29	2632	1928	2194	457	64	2715
1919	3430	387	0	3817	1929	1931	?	31	c. 2400
1920	2150	300	52	2502					

Table 3. Total Yield in Tons of the Plaice Fishery in the Skagerak in the Years 1901—1929.

Year	Denmark	Germany	Norway	Total	Year	Denmark	Germany	Norway	Total
1901	c. 1200	?	?	c. 1200	1916	451	0	28	479
1902	- 1600	?	?	- 1600	1917	592	0	39	631
1903	- 1500	121	?	- 1600	1918	303	0	31	334
1904	- 1600	203	?	- 1800	1919	702	206	31	939
1905	- 800	164	?	- 1000	1920	759	142	32	933
1906	- 900	128	?	- 1000	1921	441	63	35	539
1907	- 1000	267	?	- 1300	1922	662	70	39	771
1908	- 1200	234	46	- 1480	1923	571	19	120	710
1909	1094	186	40	1320	1924	398	76	100	574
1910	1044	123	35	1202	1925	824	69	109	1002
1911	1309	71	14	1394	1926	727	69	59	855
1912	1244	119	8	1371	1927	865	31	127	1023
1913	949	97	13	1059	1928	865	66	81	1012
1914	673	27	17	717	1929	765	79	?	c. 950
1915	622	11	18	651					

Tables 2 and 3 give a survey of the yield of the plaice fishery (in tons) during the period from 1901 to 1929 for the Kattegat and the Skagerak respectively, the Swedish yield in these waters having been included under the Kattegat.

When the total yield (in tons) for decennial periods is examined the result concerning the two seas will be as follows:

	The Kattegat	The Skagerak
1901—1910	c. 3859	c. 1350
1911—1920	- 3328	- 851
1921—1929	- 2730	- 835

It appears from this that the decrease per cent of the yield has been almost the same for the two waters. Both in the Kattegat and in the Skagerak the yield for the period 1921—29 was lower by 30 per cent than the yield during the years 1901—10. In the case of the Skagerak the average yield for the period 1911—20 was about the same as during the period 1921—29. In the Kattegat there was a more steady decrease from one decennial cycle to another.

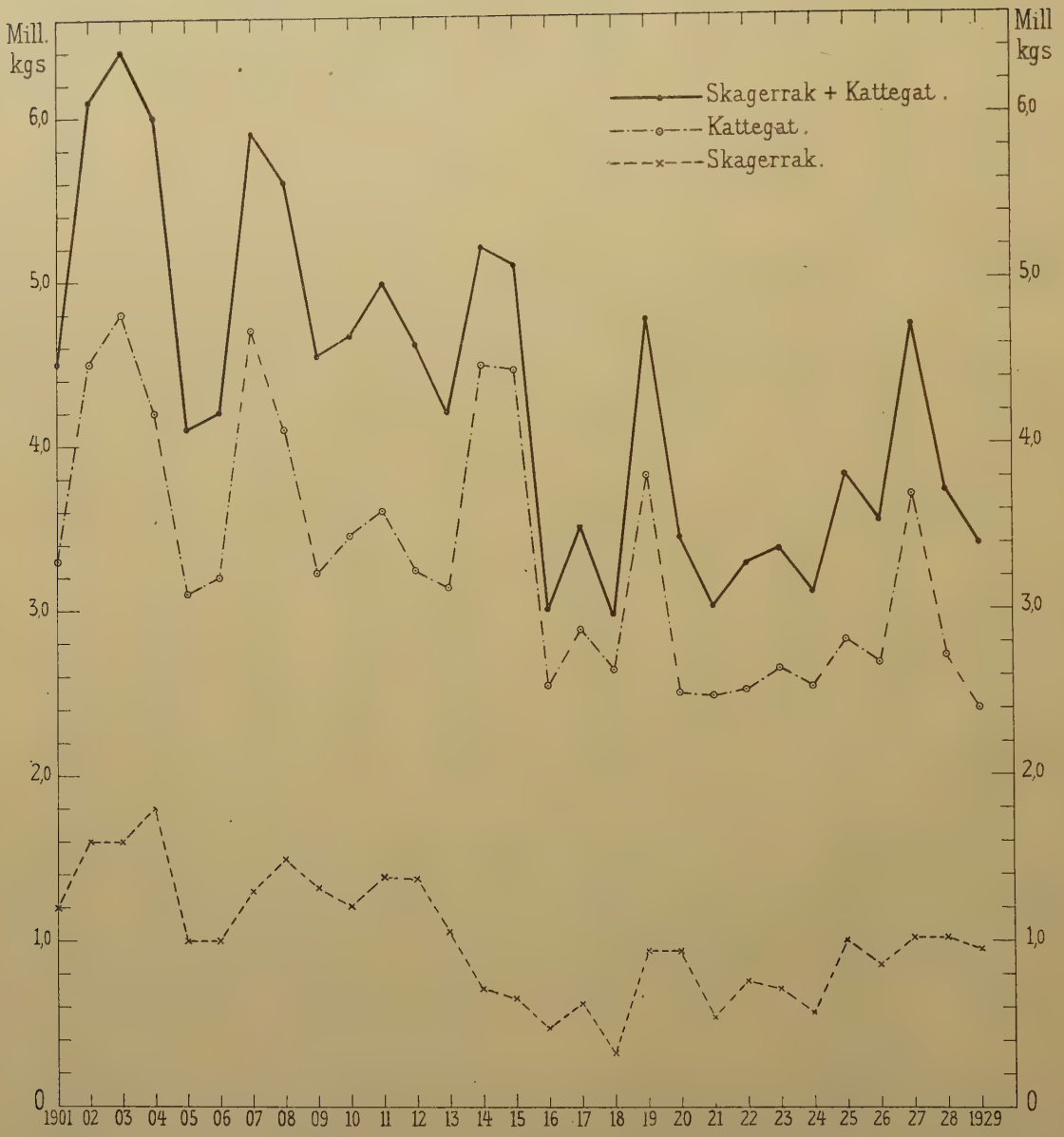

Fig. 1. Total Yield of the Plaice Fishery in the Kattegat and Skagerak (from Denmark, Germany, Norway and Sweden) in the years 1901—29.

The decrease in weight has been compensated to a certain degree by an improvement in the quality of the plaice and a rise in the prices of the same. Especially for plaice from the Southern Kattegat the improvement in the quality is considerable.

In 1914 and 1915 during the first years of the Great War the fishery was pursued with great intensity. During the last years of the war in 1916—18 it was hampered by mines, etc. Consequently the yields of the years from 1916 to 1918 were comparatively small. After the war the fisheries were intensely resumed, but only for one year, in 1919, the yield was above the normal.

During its whole course the war caused some hindrance to the fishery in the Skagerak.

The decrease in the yield of the plaice fishery in the Belt Sea has been much more serious than in the Kattegat and has been of an almost disastrous character.

During the period 1910—29 the yield of the plaice fishery in the Belt Sea was as shown below[1]):

Year	Tons	Year	Tons
1910	1467	1920	2056
1911	1777	1921	1745
1912	3352	1922	1577
1913	2681	1923	1363
1914	1463	1924	1028
1915	1011	1925	1030
1916	906	1926	854
1917	1062	1927	695
1918	1089	1928	605
1919	2655	1929	549

The comparatively small yield during the war 1914—1918 is evidently the result of the impediments caused to the fisheries by mines, etc. During these years an accumulation of the stock took place resulting in rather big yields in the years 1919 and 1920. The serious decrease of the yields in the period 1920—27 gave rise to an annual planting of about one million of young fish in the years 1928 and 1929 from the North Sea into the Belt Sea. — It will be realized that the effect of the planting has not been sufficient to stop a continued decrease of the yield although marking experiments have shown that the planted plaice has had a rapid growth (10—11 cm during one year). For the present the plaice fishery in the Belt Sea evidently seems to have reached a critical point.

3. The Methods of Fishing.

The plaice Fishery in the Kattegat and in the Skagerak is pursued by 4 nations, viz., Denmark, Sweden, Germany, and Norway. Being the absolutely predominant the Danish fishery is almost exclusively carried out from quite small craft of less than 45 metric tons and almost all the plaice caught are taken ashore alive.

Practically all the greater craft (from about 15 tons to about 45) have motors

[1]) The Western Baltic south of the Danish Islands is not included here.

and ponds for keeping the fish alive. The most important gear used in these boats is the Danish plaice seine.

Craft of less than 15 tons are as a rule also provided with motors and ponds. The fishing gears mostly used by this size of craft are the Danish plaice seine, the otter seine, and gill nets. Like the German "Zeesen" the lines of the otter seine dragged along the bottom between the otter boards and the trawl are provided with bast tufts.

During recent years the use of light otter trawls for plaice fishery has begun in the Kattegat by craft of both more and less than 15 tons, in the same way the Danish plaice seine is occasionally used as a trawl.

The majority of plaice landed by Swedish craft is caught with the Danish plaice seine from motor-crafts of a type similar to the Danish one and the main part of the plaice is carried ashore alive. Only a small part of the fisheries is carried out from steam trawlers.

The plaice taken by German fishermen in the Kattegat and the Skagerak are caught from steam trawlers and brought ashore dead. But the German fishery takes place almost exclusively outside the nursery grounds of the plaice and consequently nearly all the fishes caught are fit for sale[1]).

The Norwegian plaice fishery in the Skagerak is exclusively a coast fishery carried out from quite small craft[2]).

From this exposition it will be clear that the plaice fishery in the Kattegat and in the Skagerak is pursued in a way which spares the young fish. As a matter of fact, only a comparatively small number of the undersized fish is killed by the fisheries. By far the greater number of undersized fish caught is replaced in the water in a state fit to survive. Further, protective measures have been adopted by Denmark, Norway, and Sweden in order to spare the young fish. — In Denmark and Sweden a size limit of 25.5 cm. has been fixed for plaice. For the Norwegian coast of the Skagerak the use of certain nets and seines has been prohibited[2]). Further, the use of the Danish plaice seine and the otter seine for plaice fishery has been prohibited during the months of May, June, and July within a two mile zone along the east coast of Jutland.

4. The Intensity of Fishing.

It is impossible to give an exact survey of the changes which have taken place in the intensity with which the fishery has been pursued in the Kattegat and in the Skagerak during the period from 1901 to 1929. Statistics published in the Danish Fiskeri-Beretning concerning gears used in the plaice fishery show, however, that the intensity of fishing has been growing during the last two decennaries, (v. Table 4). It is true that the number of gill-nets has decreased but then, on the other hand, the number of the more effective fishing gears viz. Danish plaice seine and otter seine, has greatly increased. The otter seine was not used at all in these waters till about 1912, but

[1]) See E. Fischer: The present report and W. Schnackenbeck: Die Nordseefischerei in H. Lübbert und E. Ehrenbaum: Handbuch der Seefischerei Nordeuropas. Bd. V. Heft. 1. Stuttgart 1928.

[2]) See: Paul Bjerkan: The present report.

in the year 1917 the number of otter seines had reached 100 and in the period 1919—29 there were between 200 and 300 otter seines.

Of the gears mentioned in Table 4 a considerable part of the Danish plaice seines has been applied in other waters also, mainly in the North Sea.

Table 4. Number of different Gears used for the Plaice Fishery and belonging to Danish Fishermen at the coasts of the Skagerak and the Kattegat, including the Sound.

Year	Gill-Nets	Danish Seine (Snurrevaad)	Otter Seine (Skovlvaad)	Year	Gill-Nets	Danish Seine (Snurrevaad)	Otter Seine (Skovlvaad)
1909	34516	2182	0	1919	34556	2473	251
1910	35402	2086	0	1920	33085	2584	252
1911	32620	2206	0	1921	36813	2423	204
1912	32611	2300	4	1922	35455	2656	249
1913	32803	2270	5	1923	32578	2624	231
1914	35824	2332	17	1924	31570	2640	222
1915	32690	2293	38	1925	31307	2740	227
1916	36103	2096	80	1926	29847	2772	285
1917	34318	2362	100	1927	28898	2936	281
1918	35972	2298	112	1928	26017	3097	287
				1929	25099	3062	306

Table 5. Number of different Gears used for the Plaice Fishery and belonging to Danish Fishermen at the Coasts of each of the Waters: Skagerak, Kattegat and Sound.

	Gill-Nets			Danish Seine (Snurrevaad)			Otter Seine (Skovlvaad)		
Year	Skagerak	Kattegat	Sound	Skagerak	Kattegat	Sound	Skagerak	Kattegat	Sound
1909	858	30825	2833	229	1847	106	0	0	0
1910	756	29273	5373	219	1748	119	0	0	0
1911	770	28200	3650	220	1880	106	0	0	0
1912	741	28860	3010	231	1996	73	1	3	0
1913	855	28380	3568	214	1985	71	1	4	0
1914	484	30770	4570	201	2059	72	1	16	0
1915	688	27314	4688	177	2054	62	1	35	2
1916	616	31377	4110	141	1883	72	2	73	5
1917	568	30370	3380	146	2146	70	3	89	8
1918	581	32441	2950	133	2103	62	3	103	6
1919	591	31060	2905	140	2259	74	3	237	11
1920	535	29205	3345	147	2345	92	3	238	11
1921	495	33623	2695	139	2179	105	2	190	12
1922	470	32060	2925	157	2396	103	2	234	13
1923	330	28948	3300	143	2377	104	2	205	24
1924	326	27954	3290	117	2431	92	0	186	36
1925	330	27364	3613	119	2517	104	0	193	34
1926	358	25859	3630	132	2537	103	0	248	37
1927	408	25230	3260	129	2704	103	1	242	38
1928	440	22789	2788	112	2893	92	1	265	21
1929	418	21911	2770	114	2862	86	5	273	28

Table 5 gives a survey of the number of gears distributed on the various seas. It appears from this that the otter seine is mostly employed in the interior Danish waters and only slightly used in the Skagerak.

The Danish fishing craft of more than 15 tons belonging to the coasts of the Skagerak, the Kattegat, and the Sound are chiefly used for fishing plaice and other flat fishes. As will be realized from Table 6 the number of these craft, all of which are provided with motors, has increased considerably during the period 1912—28. As a matter of fact, however, a considerable number of these craft has been employed in fishing in other waters, mainly in the North Sea:

Table 6. Number of Danish Cutters above 15 Tons belonging to the Coasts of the Skagerak, the Kattegat, and the Sound (from Fiskeri-Beretning).

Year	Number	Year	Number	Year	Number
1912	156	1918	197	1924	221
1913	152	1919	190	1925	237
1914	178	1920	191	1926	254
1915	184	1921	203	1927	254
1916	168	1922	203	1928	268
1917	178	1923	212		

5. The Cause of the Decrease in the Yield of the Plaice Fishery.

As it appears from Chapter 3 the main part of the plaice fisheries in the Kattegat and in the Skagerak is pursued with gears which are relatively sparing to the stock of undersized fish. The introduction of the otter seine into the plaice fishery of the Kattegat, however, does not mean any improvement in the method of fishing as the otter seine does more harm to the stock than the Danish seine. Evidently the decrease in the yield is due to the fact that the fishing is so intensively pursued that the measures which have been adopted to protect the stock have proved insufficient. Too many small plaice of a length from 25—27 cms. are caught, and there is some evidence to hand that in the course of time, the stock of mature fish has been reduced too much owing to the intense fishing. The modern fishery is predominantly based on immature fish of the II-Gr. and III-Gr.

As pointed out by the author on previous occasions[1]) there was still in the eighties and nineties of the 19th century a big accumulated stock of old mature plaice in the Skagerak and in the northern part of the Kattegat, but this stock was rapidly reduced by the fisheries, and within this period the average size of the fish landed greatly decreased. — In the southern part of the Kattegat an accumulated stock of mature plaice remained longer than in the Skagerak and in the northern part of the Kattegat owing to the fact that these fishes for a long time were relatively small and lean and consequently of little value. During the last decennaries, however, this stock has been much reduced. At the

[1]) A. C. Johansen: Ueber die Schollenfischerei im Kattegat, etc. Rapports et Procès-Verb. Vol. V, 1906.

Fig. 2. The most important Nursery Grounds for the Plaice in the Skagerak and Kattegat (indicated by hatching).

same time, the quality of the fish greatly improved as the quantity of nourishment per fish increased which resulted in an increased growth of the individual fish and put an end to its dwarfish character. As it will be seen from AAGE J. C. JENSEN's paper in the present report, it has been possible to trace down to the last decennium the process which has been working on the stock of plaice in the southern Kattegat during a long period, viz., a decrease of the average age of the fish landed and an increase of the average size of fish of a certain age.[1])

[1]) Comp. C. G. JOH. PETERSEN: On the stock of Plaice in relation to the intensive fishing etc. Report XXVII from the Danish Biological Station 1920.

There is some reason for assuming that a reduction in the production of fry has taken place coincident with the great decrease in the stock of mature plaice in the Skagerak and in the Kattegat during the period 1880—1920. This view is supported by the fact that more individuals belonging to the 0-Gr. were caught per fishing unit by the Danish experiments for the 0-Gr. plaice in the best brood years within the period 1905—13 than in the best brood years of the period 1920—29[1]).

The stock of plaice in the Kattegat and in the Skagerak is not entirely renewed by itself. An annual indrift of larvae from the North Sea into the Skagerak takes place together with an annual migration of young fish from the Skagerak into the Kattegat. We do not possess sufficient information as to whether a decrease of this indrift of larvae and this migration of young fish has taken place in the course of years, but it is very likely the case, as it appears from numerous reports that the stock of mature plaice considerably decreased in the catches in the eastern part of the North Sea as early as in the nineties of the 19th century[2]). In the period 1922—29 very few mature plaice were brought to Danish harbours from the eastern part of the North Sea.

6. Conclusions.

The facts set forth in the present report advocate the adoption of further measures for protection or increase of the stock of plaice in the Kattegat and in the Skagerak. The following measures ought to be considered:

1) The introduction for Denmark, Norway, and Sweden of a size limit larger than that at present in force for Denmark and Sweden.
2) Prohibition against the employment of the otter-trawl from steam-trawlers and big motor craft belonging to Denmark, Germany, Norway, and Sweden on the most important nursery grounds for the plaice in the western part of the Kattegat.
3) Transplantation of young plaice from the nursery grounds in the eastern part of the North Sea to certain places in the Kattegat.

A further protection of the plaice in the Kattegat and adjacent waters will probably cause an increase of the stock, and the question then arises whether the food conditions are at present favourable for such an increase. Dr. Blegvad has recently investigated this question[3]) and has arrived at the result that only a small part of the food suitable for the plaice in the Kattegat is utilized by this species. Even on the nursery grounds for the plaice West of the line Fornæs Light—West End of Læsø—Nordre Rønner Light—Skagen Lightship there is, according to Dr. Blegvad, a considerable surplus of plaice food.

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[1]) Comp. A. C. Johansen: On the Fluctuations in the Quantity of Young Fry among Plaice, etc. Report XXXIII, Danish Biological Station. 1927.

Idem: Transition Area. 1929. Rapports et Proc. Verb. Vol. LXVI. 1930.

[2]) A. C. Johansen: Contributions to the Biology of the Plaice I. Medd. f. Komm. f. Havunders. Ser. Fiskeri. Bd. I. 1905.

[3]) H. Blegvad: Quantitative Investigations of Bottom Invertebrates in the Kattegat with special Reference to the Plaice Food. Report Danish Biol. Station XXXVI. 1930.